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OBSERVATIONS

ON THE

GEOLOGY

OF THE

UNITED STATES OF AMERICA;

WITH

SOME REMARKS

ON THE

EFFECT PRODUCED ON THE NATURE AND FERTILITY OF

SOILS,

BY THE DECOMPOSITION OF THE DIFFERENT

CLASSES OF ROCKS;

AND AN APPLICATION TO THE FERTILITY OF EVERY STATE IN THE UNION,
IN REFERENCE TO THE ACCOMPANYING GEOLOGICAL MAP.

WITH TWO PLATES.

BY WILLIAM MACLURE.

Read as a Memoir before the American Philosophical Society, and inserted in the 1st vol. of their Transactions, New Series.

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1817.

Why mankind should have so long neglected to acquire knowledge so useful to the progress

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The head of the Mississippi is
Part of

OBSERVATIONS

ON THE

GEOLOGY OF THE UNITED STATES.

PREFACE.

All inquiry into the nature and properties of rocks, or the relative situations they occupy on the surface of the earth, has been much neglected. It is only since a few years that it has been thought worth the attention of either the learned or unlearned; and even now, a great proportion of both, treat such investigations with contempt as beneath their notice.

The Germans were amongst the first who began to make accurate observations in this branch of science. **Werner** reduced the nomenclature to some regular form, and founded his system on the relative situations of the different classes of rocks. Although subject to all the errors inseparable from systems founded upon a speculative theory of origin, the system of Werner is still the best and most comprehensive that has yet been formed.

Why mankind should have so long neglected to acquire knowledge so useful to the progress of civilization—why the substances over which he has been daily stumbling, and without whose aid he could not exercise any one art or profession, should be the last to occupy his attention—is one of those problems, perhaps only to be solved by an analysis of the nature and origin of the power of the few, over the many.

The science of Geology, until lately, has been confined to speculative theories on the origin and formation of the earth. Whether they have made any progress toward the discovery of that hidden mystery, or whether the last theory is nearer the truth than the first, is difficult to decide; for we have no data, no scale by which we can measure their relative merits. Each new theory is ushered in, by its author attempting to refute all former theories; but it is still doubtful whether success will repay the labour of so many men of brilliant imaginations, who have exerted their talents to make the discovery of the earth's origin. Meanwhile, the useful application of the substances found on the earth's surface, to arts, manufactures and science, has been rapidly progressing in proportion to the increase of positive knowledge; following in this respect, during great part of the last fifty years, the usual steps of rational civilization.

In all speculations on the origin, or agents that have produced the changes on this globe, it is probable that we ought to keep within the boundaries of the probable effects resulting from the regular operations of the great laws of nature which our experience and observation has brought within the sphere of our knowledge.

When we overleap those limits, and suppose a total change in nature's laws, we embark on the sea of uncertainty, where one conjecture is perhaps as probable as another; for none of them can have any support, or derive any authority from the practical facts wherewith our experience has brought us acquainted. The equator has been supposed to have been once where the poles are now, to account for the bones of the animals now living near the tropics being found in the higher latitudes; yet without any change either in the poles or equator, it is certainly not impossible but even probable, that these animals, before their tyrant man obstructed their passage, might migrate to the north during nearly three months of the summer; and might have a sufficient quantity of heat, and a much greater abundance of nourishing vegetable food, than the torrid zone could afford them at that season.

There does not appear to be any thing either in the climate or food that could prevent the elephants, rhinoceroses, &c. from following the spring into the north, and arriving in the summer even to the latitude of 50 or 60 degrees, and retiring to the warmer climates on the approach of the winter; on the contrary, it would appear to be the natural course of things, and what I believe our buffaloes in the uninhabited parts of our continent still continue to do; that is, to migrate in vast droves from south to north, and from north to south, in search of their food, according to the season.

The birds and the fish continue their migrations, passing by roads out of the reach of man; the natural change of place which their wants require, has not been barred and obstructed by the united power and industry of the lords of the creation.*

To specify the many practical advantages arising from the knowledge of the nature and relative positions of the rocks which cover the surface of the earth, would require volumes. Here, it is only proposed to mention a few, which almost every man, during some period of his life, may find the necessity of resorting to.

First, from the knowledge of the relative situation of rocks and from an accurate investigation of the usual succession of one species of rocks to another, we are guided in our search for coal, gypsum, salt, limestone, millstones, grindstones, whetstones, *&c.*; as well as the probable places where to look for all kinds of metallic veins and repositories: for example, coals have not been found under any species of primitive rocks; of course, we should not look for them in that class, and if when digging for coal, we should come to the primitive rocks, we should desist. Coals have not been found in any profitable quantities under any considerable bed of limestone, &c. &c. Wolfram accompanies tin in the greatest part of the tin mines; of course the appearance of wolfram is a sign, that most probably tin may be found in the vicinity, &c. Great sums of money have been lost in the United States, and in other countries, by digging for substances among classes of rocks, which have never been found to contain them elsewhere; and of course the probability was against their being found in that class of rocks here.

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* Until lately we have restricted nature to two modes of acting; by fire, and by water: now, it is found, that she can change and metallize rocks in the dry way, without any solution or fluidity; and the galvanic pile may be formed in the stratifications of a mountain, as well as in a chemist's laboratory. These are two other modes wherein we must now allow her to change and modify the surface of this earth; and who can say how many more means yet unknown, she may possess? each of which, when found out by accurate and impartial observation, must make a change in former theories.

A knowledge of the nature and properties of rocks, and the results of their decomposition, enables us to judge of their hardness, easy or difficult decomposition, their component parts, mode of splitting, &c. by which we judge of their fitness for house buildings, roofing, road making, burning for lime, china or pottery, brick making, glass making, hearths for forges and furnaces, &c. We likewise know, by previous experience, the nature and richness of any metallic ore that may be found, and can calculate from the expense of procuring any ascertained quantity, whether the mine will pay for the working. It is thus we may avoid the losses of digging for species of ore, such as pyrites, that is worth little or nothing; as well as expending money in working a mine that was not rich enough to pay the labour. Much money might be saved by this kind of knowledge, in road making, where it frequently happens that a rock, such as limestone, slate, serpentine, &c. which would not perhaps last three months, is taken in preference to a quartz or hornblende rock, that would wear one or two years. Expense is often incurred by making and burning bricks, that are useless from the clay containing too great a quantity of calcareous matter; or of burning lime when the stone attempted to be burned contains too little of calcareous, and too much of argillaceous or other foreign matter, which prevents it being reduced to quicklime; all which, the proper application of a small quantity of acid might prevent.

It may be objected, that there are professional men who will give advice on these subjects, on better terms than we can acquire ourselves the necessary knowledge; but it is sometimes the case with all kinds of counsellors, that they are more interested in the profits of the process, than in the profits of the result: and when it is considered, that less than half the time necessary to give a smattering of any of the dead languages at our academies, would be more than sufficient to give our youth a complete knowledge of the common and useful applications of earths and rocks, we may reasonably hope that ere long some portion of time will be appropriated in our colleges and universities, to studies of undisputed utility; and that a knowledge of substances, their properties and their uses, will be permitted in some degree to encroach on the study of mere words. The time seems fast approaching when what is called learning will not in all cases be deemed, as it has been in too many, synonymous with knowledge.

The greatest part of the first and second chapters of these observations was published in the sixth volume of the Philosophical Transactions, at Philadelphia, with the geological map. This was afterwards translated into French, and published in the Journal de Physique, for February, 1812, accompanied also by a geological map; since which we are indebted to the active attention of Dr. S. L. Mitchill,* for the only correction that has since been made, which consists in extending the alluvial over the whole of the east end of Long island, whereas we had supposed that the alluvial of the northern skirts of the island had rested on primitive. During an excursion last summer, an opportunity was afforded of ascertaining and extending the limits of the transition in the states of Pennsylvania and New York, as well as the boundaries of the great primitive formation, north of the Mohawk; and fixing the limits of the transition on Lake Champlain and in the state of Vermont with more precision.

The third and fourth chapters, are an attempt to apply Geology to agriculture, in showing the probable effects the decomposition of the different classes of rocks may have on the nature and fertility of soils. It is the result of many observations made in Europe and America, and may perhaps be found more useful in the United States than in Europe, as more of the land is in a state of nature, not yet changed by the industry of man.

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* Dr. Bruce's Mineralogical Journal, vol. i.

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CHAPTER I.

General Remarks on the Method of pursuing Geological Researches, with a few Observations on the different Chains of European Mountains, compared with those of the United States of America.

The examination of the different substances which cover the exterior of the globe, may be commenced and pursued in two ways, both leading to the same point, though by opposite roads. The *first*, beginning by an accurate investigation of a small portion of the surface, describing exactly the different rocks, with their immense variety of arrangement in the position of their component parts, detailing the changes accidental or natural constantly occurring in their relative situation, and endeavouring to reduce the whole into some regular series of arrangement. This method necessitates the reunion of a great number of those portions, before any correct general ideas can be formed.

The *second*, beginning with the great outlines, traces the limits which divide the principal classes of rocks, and their relative situations and extents; leaving the examination of the vast variety, contained in each class, to be regulated by the general principles previously acquired.

The method founded on accurate observation, though limited in extent, would appear to be the best, and confirmed by the practice of acquiring all the other sciences; and yet on a further examination, there are serious objections arising from the difficulty of the execution, on account of the great variety and imperceptible shades of gradation from one kind of rock to another; which would render the nomenclature extensive and intricate, necessitating long and voluminous descriptions, conveying imperfect ideas, that rather fatigue than instruct: for example, it would require a volume to describe all the varieties of rocks found in a range of forty leagues of the primitive formation; and in two leagues, either to the right or left of the same range, the changes would fill another volume.

In tracing the outlines of the different formations in most countries, there is less confusion and embarrassing description necessary; the limits once ascertained, a few pages define the boundaries, and explain the relative situations to the comprehension of every reader. For example: in the north of Europe, Norway is primitive with a few exceptions, the greatest part of which is the basin surrounding Christiania, which is transition. Sweden is primitive, except the southern part in Scania, and part of the coast of the Categat, with some of the borders of the great lakes, which are secondary. Both sides of the gulf of Bothnia to the North cape, and from thence through Finland to St. Petersburg are primitive. From St. Petersburg to the secondary limestone of the Crimea is alluvial, except in three places, a narrow bed of chalk at Sewsk, twelve posts south-west of Tula, between Bogouslaw and Corsoun, eight posts south of Kiew, and from Elisabethgrad four posts to Wodinaria, where the primitive appears in the beds of the rivers. The secondary limestone of the Crimea is succeeded by the transition, about one and a half league south of Simphiropol, and the whole range of mountains along the Black sea on the south side of the Crimea is transition.

The south side of the Baltic is an extensive alluvial formation, bounded in Poland by the secondary limestone at the foot of the Carpathian mountains, in Silesia and Saxony by the edge of the secondary limestone that covers the foot of the Bohemian mountains, and so along the Thuringwald and Hartz to the North sea. Between these mountains and the Baltic, is one continued plain of alluvial with few or no exceptions, the exact limits of which would be easily ascertained, and still more easily described, to the understanding of every one; even the omission of some exceptions would not materially affect the utility, as they would be rectified by the next observer.

Another inconvenience seems to arise out of the method of examining minutely a small portion, or part of one range of mountains, and that is the formation of a system which, though according exactly with the structure of the country examined, is too often in contradiction with the nature and formation of most others; tending in very many cases to perplex the reader, and throw the whole into discredit. In the present state of geological knowledge, an accurate definition of the rocks, commonly found united in great and extensive masses, with the limits of separation between them and rocks of the other great classes or formations, might perhaps be the plainest and most certain mode of increasing our knowledge, correcting the errors of the vast number of old, and throwing more light on the formation of new systems.

The short period of time that mankind seem to have been capable of correct observation, and the minute segment of the immense circle of nature's operations, that has revolved during the comparatively short period, renders all speculations on the origin of the crust of the earth mere conjectures, founded on distant and obscure analogy. Were it possible to separate this metaphysical part from the collection and classification of facts, the truth and accuracy of observation would be much augmented, and the progress of knowledge much more certain and uniform; but the pleasure of indulging the imagination is so superior to that derived from the labour and drudgery of observation—the self-love of mankind is so flattered by the intoxicating idea of acting a part in the creation—that [illegible] scarcely expect to find any great collection of facts, untinged by the false colouring of systems.

The peculiar structure of the continent of North America, by the extended continuity of the immense masses of rocks of the same formation or class, with the uniform structure and regularity of their uninterrupted stratification, forces the observer's attention to the limits which separate the great and principal classes; on the tracing of which, he finds so much order and regularity, that the bare collection of the *facts* partake somewhat of the delusion of theory.

The prominent feature of the eastern side of the continent of North America, is an extended range of mountains, running nearly north-east and south-west from the St. Lawrence to the Mississippi, the most elevated parts as well as the greatest mass of which consists of *primitive* as far south as the Hudson river, decreasing in height and breadth as it traverses the state of New Jersey. The primitive occupies but a small part of the lower country, where it passes through the states of Pennsylvania and Maryland, where the highest part of the range of mountains to the west consists of transition, with some intervening vallies of secondary. In Virginia, the primitive increases in breadth, and proportionally in height, occupying the greatest mass, as well as the most elevated points of the range of mountains in the states of North Carolina and Georgia, where it takes a more westerly direction.

Though this primitive formation contains all the variety of primitive rocks found in the mountains of Europe, yet neither their relative situation in the order of succession, or their relative heights in the range of mountains, correspond with what has been observed in Europe. The order of succession from the clay state to the granite, as well as the gradual diminishing height of the strata, from the granite through the gneiss, mica slate, hornblende rocks, down to the clay slate, is so often inverted and mixed, as to render the arrangement of any regular series impracticable.

No secondary limestone has been found on the south-east side of the primitive, nor any series of other secondary rocks, except some partial beds of the old red sandstone formation, which partly cover its lower edge; in this, it seems to resemble some of the European chains, such as the Carpathian, Bohemian, Saxon, Tyrolian and Alpine or Swiss mountains; all of which, though covered with very extensive secondary limestone formations on their north and west flanks, have little secondary limestone on their southern and eastern sides.

The old red sandstone above mentioned, covers partially the lower levels of the primitive, from twelve miles south of Connecticut river to near the Rappahannock, a range of nearly four hundred miles; and though often interrupted, yet retains through the whole distance that uniform feature of resemblance so remarkable in the other formations of this continent. The same nature of sandstone strata is observable, running in nearly the same direction, partially covered with wacke and greenstone-trap, and containing the same metallic substances. The above uniformity is equally observable in the great alluvial formation which covers the south-east edge of the primitive, from Long island to the gulf of Mexico, consisting of sand, gravel, &c. with marsh and sea mud or clay, containing both vegetable and animal remains, found from thirty to forty feet below the surface.

Along the north-west edge of the primitive, commences the *transition* formation, occupying, after the primitive, some of the highest mountains in the range, and appears to be both higher and wider to the west in the states of Pennsylvania, Maryland, and part of Virginia, where the primitive is least extended, and lowest in height. It contains all the varieties of rocks found in the same formation in Europe, as the mountains in the Crimea, &c. and resembles in this the chain of the Carpathian, Bohemian and Saxon mountains, which have all a very considerable transition formation, succeeding the secondary limestone on their northern sides. Anthracite has been found in different places of this formation, and has not yet been discovered in any of the other formations in North America.

The necessity of such a class or division of rocks as the *transition*, has been doubted by some, nor is it now generally used in the south of Europe; but such rocks are found, and in very considerable quantities, in almost every country that has been examined. There are only two classes, the primitive or secondary, in which they can be placed. They are excluded from the primitive, by containing pebbles, evidently rounded by attrition when in an insulated state, and by the remains of organic substances being found, though rarely, in them; and yet many of the variety of transition rocks, such as the grey wacke slate, and quartzose aggregates, are hardly distinguishable from primitive slate and quartz when fresh; it is only in a state of decomposition, that the grain of the transition rocks appears, and facilitates the discrimination.

If they are placed with the secondary, they would form another division in the class, already rather confusedly divided; as their hardness, the glossy, slaty, and almost chrystalline structure of the cement of a great proportion of the transition aggregates, would exclude them from any division, as yet defined, of the other secondary rocks. Besides the objections arising out of their individual structure, the nature of their stratification removes them still further from the secondary, and makes them approach still nearer to the primitive. They are found regularly stratified, generally dipping at an angle above twenty and not exceeding forty-five degrees from the horizon; whereas, the secondary rocks are either horizontal or undulating with the inequalities of the surface. A bed of grey wacke, or grey wacke slate and transition limestone, runs south-west from the Potomac to near the Yadkin river, a distance of two hundred miles, from one to five miles in breadth, having the primitive formation on each side, dipping the same as the primitive, though at a less angle, the strata running in the same direction; and from its relative situation, dip, and stratification, bearing no characters of the secondary, not having been yet found alternating with secondary rocks, it cannot be classed with them, without destroying all order and introducing confusion. To class it with the primitive, would be making the primitive include not only aggregates composed of pieces of different kinds of rocks rounded by attrition, but also limestone with a dull fracture, coloured by organic or other combustible matter, which it loses by being burnt. It would perhaps add to the precision of the classification, if this class was augmented by placing some of the porphyritic and other rocks in it, which are more of an earthy than chrystalline fracture, but which at present are considered as primitive.

It might have been as well if, when giving names to the different classes of rocks, all reference to the relative period of their origin or formation had been avoided; and in place of *primitive* and *secondary*, some other names had been adopted, taken from the most prominent feature or general property of the cl[illegible] of rocks intended to be designated, such as perhaps chrystalline in place of primitive—deposition or horizontal in place of secondary, &c.; but as those old names are in general use, and consecrated by time and long habit, it is more than probable that the present state of our knowledge does not authorise us to change them. The adoption of new names, on account of some new property discovered in the substance is the cause of much complication and inconvenience already; and if adopted as a precedent in future, will create a confused accumulation of terms calculated to retard the progress of the science. When we change the names given to defined substances, by those who went before us, what right have we to suppose, that posterity will respect our own nomenclature?

On the north-west side of the transition formation, along the whole range of mountains, lays the great *secondary* formation, which, for the extent of the surface it covers and the uniformity of its deposition, is equal in magnitude and importance, if not superior, to any yet known: there is no doubt of its extending to the borders of the great lakes to the north, and some hundred miles beyond the Mississippi to the west. We have indeed every reason to believe, from what is already known, that the limits of this great basin to the west, is not far distant from the foot of the Stony mountains; and to the north, that it reaches beyond Lake Superior, giving an area extending from east to west from Fort Ann, near Lake Champlain, to near the foot of the Stony mountains, of about fifteen hundred miles, and from south to north from the Natchez to the upper side of the great lakes, about twelve hundred miles.

This extensive basin is filled with most of the species of rocks, attending the secondary formation elsewhere, nor is their continuity interrupted on the east side of the Mississippi by the interposition of any other formation except the alluvial deposits on the banks of the large rivers. The foundation of most of the level countries is generally limestone, and the hills or ridges in some places consist of sandstone: a kind of dark coloured slaty clay, containing vegetable impressions, with a little mixture of carbon, frequently alternates with all the strata of this formation, the whole of which is nearly horizontal. The highest mountains are on the external borders of the basin, gradually diminishing in height towards its centre.

Two divisions of the secondary formation common in Europe have not yet been discovered in this—the chalk formation, and what Werner calls the newest floetz-trap formation. The limestone generally found in this basin is of a bluish colour, running through all the shades to a dingy black, having an even, rather earthy fracture, and sometimes a schistose structure. The flints found in the secondary limestone in America, are generally black, resembling the Lydian stone, and in all kind of irregular forms and branches intimately mixed with the limestone. The limestone, which often follows the chalk formation in countries where chalk has been found, is generally of a white, running into a drab or light-brown colour, a smooth, compact, conchoidal, almost resembling the flinty fracture; having in some parts of the stratum rounded nodules of flint, interspersed apparently without order; the flints in some places light coloured, in others dark; and some of the nodules whitish on the outer edge, and blackish towards the centre.

A very extensive and regular formation of the above mentioned kind of limestone, succeeds the chalk in Europe, and covers the transition formation on the north side of the mountains of the Crimea; holds the same relative situation along the north side of the transition on the Carpathian mountains; continuing through Silesia and Bavaria along the Bohemian mountains to Ratisbon; from thence up the Danube, to Schaffhausen on the Rhine; and follows the north-west side of the Jura, across the Rhone to the Mediterranean: the limestone during this long course, is similar, both in colour and structure; and in some places on the banks of the Danube, is in a schistose form. It is this kind of limestone wherewith they make the plates which afford such exact impressions of writings and designs at Munich; its compact, homogenous structure, without any grain, renders it capable of receiving almost a metallic polish.

The absence of the newest floetz-trap formation (which partially and irregularly covers all other formations, thereby breaking the continuity of the other strata) with the effect of the violent convulsions and earthquakes, so frequent in the vicinity of this disputed formation, may be one cause why the prosecution of geological researches is so much more easy in North America than in Europe. A second cause producing much more universal and extensive effects, may perhaps be found in the difference of the number and magnitude of the accidents and changes that have been effected in the stratifications of the different classes of rocks on the European continent, since their original formation; by the effects of water, during the immensity of time, partially washing away the superincumbent strata, most liable to decomposition, and leaving the more hard and durable parts of the same stratification in their original positions; or by the long and continual action of rivers wearing deep beds, and exposing to view the subordinate strata, giving to the whole the present appearance of a confused and interrupted stratifications, though it might have been uniform and regular in its original state. Rivers likewise, by undermining, throw immense masses out of their places, and create a disorder and confusion, not easily unravelled.

A third cause of the facility of geological observations on this continent, may arise from the whole continent east of the Mississippi following the arrangement of our great chain of mountains. This chain commences at the St. Lawrence river, and appears to be a spur from the great mass of primitive, which occupies all the northern parts of the continent, runs a southwesterly course to the borders of Florida, is covered by the alluvial, and bounded by the sea on the east side; on the west side it is covered with a considerable transition formation, which is followed by a still more extensive secondary formation, all of which run in a regular line of continuity. Europe, on the contrary, is formed of five or six chains of mountains, all following different laws of stratification, and frequently interrupting each other; which increases the difficulty of arranging them in groups, and augments the apparent confusion.

The rivers in North America have not generally cut so deep into the different strata, either in the mountains, or during their course through the level country, as materially to derange the stratification; nor do we find those immense and inaccessible precipices, which renders the prosecution of geological researches almost impossible. Broken, detached masses of one formation, covering the tops of mountains, with their sides or foundation composed of different classes of rocks, seldom occurs; and where any irregularity or apparent confusion takes place, the vicinity generally admits of a sufficient examination of the surrounding strata, so as to account for the accident without affecting the general arrangement.

The stratification of the great chains of mountains in Europe is so cut up and deranged by the action of water, wearing deep vallies, surrounded by inaccessible precipices, that at every step some unaccountable difficulty occurs; the stratification is irregular and contradictory, the constant alternation of different formations baffles all the research which the nature of the place will permit of: if persevering industry, by accurate and minute investigation, should reduce to some order one part of the chain, another part of the chain of mountains, changed by different series of accidents, cannot be reduced to order by the same rules; and the observer may perhaps find, that he has not been acquiring the knowledge of the natural structure and arrangement of the original stratification, but only an imperfect idea of some accidental changes. It is probable in such cases, that it would be better to begin with taking general and extensive views of the whole chain, endeavouring to find out the key to the original order of stratification, which would render it more easy to account for the accidents which, when examined separately, appeared to be irreconcileable exceptions.

The difference between the ranges of mountains in Europe and North America, appears to be much greater, as respects the accidental and subsequent changes, than in the original order and arrangement of their stratification, in the relative situation whereof they frequently agree. On the edge of the secondary, not far distant from the transition, have been found the most productive salt springs, yet discovered in North America, running nearly north-east from Pigeon's river in the state of Tennessee, to Lake Onondaga; the salt works at Abingdon, and many other salt springs, though not wrought, occur; and in the same direction of the stratification, gypsum has been discovered. This situation of salt and gypsum, corresponds with the situation of the salt mines at Cracovia in Poland, which, with some others in the same country, are found on the edge of the secondary, almost touching the great transition formation, which covers the north side of the Carpathian mountains.

The country round the Baltic, bounded by a line running easterly to the Hartz, through Silesia, along the Carpathian mountains to the Crimea, and north by St. Petersburgh, including Denmark, part of Russia, Prussia, Finland, Sweden and Norway, is similar to the east side of the river Mississippi in North America, inasmuch, as it contains little or none of the basalt or newest floetz-trap formation; and very few warm springs, in proportion to the surface, have been yet found in either of the countries above mentioned; though on the south side of that line in Hungary and Bohemia, the floetz-trap formation and hot springs are frequent; and in crossing the stony mountains on the west side of North America, between the sources of the Missouri and Columbia river, two very hot springs were found by Captain Lewis: the same mountains likewise contain rocks of the newest floetz-trap formation.

The shells and other remains of organized matter, have not yet been examined with that accuracy of discrimination necessary to form just conclusions. Those found on the south-east side of the primitive are almost exclusively contained in the alluvial, in which considerable banks of shells, mostly bivalves, run parallel to the coast, imbedded frequently in a soft clay or mud resembling much that in which the living animal is now found on the sea shore, which makes the supposition probable, that they are of the same species. The shells found north-west of the primitive range, in the great secondary formation, are in great abundance, and consist of various species of Terebratulæ, Encrinites, Madripores, Caryophillites, Ammonites, Retipores, Nummulites, &c. most of which being washed out of the banks by the agitation of the water, are to be found in high preservation on the south side of Lake Erie.

CHAPTER II.

Observations on the Geology of the United States of America, in Explanation of the geological Map.

Necessity dictates the adoption of some system, so far as respects the classification and arrangement of names. The Wernerian seems to be the most suitable, first, because it is the most perfect and extensive in its general outlines—and secondly, the nature and relative situation of the minerals in the United States, whilst they are certainly the most extensive of any field yet examined, may perhaps be found the most correct elucidation of the general accuracy of that theory, so far as respects the relative position of the different series of rocks.

Without entering into any investigation of the origin, or first formation of the various substances, the following nomenclature will be used.

CLASS I.—Primitive Rocks.

SIENA BROWN.

1. Granite,
2. Gneiss,
3. Mica Slate,
4. Clay Slate,
5. Primitive Limestone,

6. Primitive Trap,
7. Serpentine,
8. Porphyry,
9. Sienite,
10. Topaz-rock,
11. Quartz-rock,
12. Primitive Flinty-slate,
13. Primitive Gypsum,
14. White-stone.

CLASS II.—Transition Rocks.

CARMINE.

1. Transition Limestone,
2. Transition Trap,
3. Grey Wacke,
4. Transition Flinty-slate,
5. Transition Gypsum.

CLASS III.—Flœtz or Secondary Rocks.

LIGHT BLUE.

1. (*dark blue*) Old Red Sandstone, or 1st Sandstone Formation,
2. First or Oldest Flœtz-limestone,
3. First or Oldest Flœtz-gypsum,
4. 2d or Variegated Sandstone,
5. 2d Flœtz-gypsum,
6. 2d Flœtz-limestone,
7. 3d Flœtz-sandstone,

8. Rock-salt Formation,
9. Chalk Formation,
10. Flœtz-trap Formation,
11. Independent Coal Formation,
12. Newest Flœtz-trap Formation.

CLASS IV.—Alluvial Rocks.

YELLOW.

1. Peat,
2. Sand and Gravel,
3. Loam,
4. Bog Iron-ore,
5. Nagel-fluh,
6. Calc-tuff,
7. Calc-sinter.

GREEN.

All the rock salt and gypsum hitherto found in the United States, has been traced westward of this line.

To the east of Hudson's river, the primitive class prevails, both in the mountains and in the low lands, decreasing gradually as it proceeds south; it is bounded on the side of the ocean by the vast tracts of alluvial formation which skirt the great granite ridge, while it serves as a foundation to that immense superstructure of transition and secondary rocks forming the great chain of mountains that occupy the interior of the continent to the westward.

The primitive, to the eastward of Hudson's river, constitutes the highest mountains, while the little transition and secondary that is found, occupy the low grounds. To the south of the Delaware, the primitive is the first rock after the alluvial formation of the ocean—the lowest step of the stair which gradually rises through the different formations to the top of the Alleghany.

To the eastward of the state of New York, the stratification runs nearly north and south, and generally dips to the east, looking up to the White Hills, the most elevated ground. In New York state, and to the southward and westward, the stratification runs nearly north-east and south-west, and still dips to the east. All the rivers east of the Delaware run nearly north and south, following the stratification, while the southern rivers incline to the south-east and north-west directions.

Throughout the greatest part of the eastern and northern states, the sea washes the foot of the primitive rock; the deposition of that extensive alluvial formation commences at Long island, increasing in breadth to the south, forming a great part of both the Carolinas and Georgia, and almost the whole of the two Floridas and lower Louisiana. The coincidence of the gulf stream, with all its attendant eddies, depositions, &c. rolling along this whole extent, from the gulf of Mexico to Nantucket, may create speculative ideas on the origin of this vast alluvial formation, while the constant supply of caloric brought by that sweeping current from the tropics, may perhaps account for the sudden and great change in the temperature of the climate within the reach of the Atlantic.

The great distance occupied by the same or similar substances in the direction of the stratification, must strike the observer; as in the primitive rocks, the beds of primitive limestone and dolomite, containing in some places chrystallized feldspar and tremolite, which are found alternating with gneiss, for ten miles between Dover, state of New York, and Kent, state of Connecticut, appear forty miles north at Stockbridge, Connecticut, and eighty miles south, between Singsing and Kingsbridge, New York; where, after crossing the Hudson river, and dipping under the trap and sandstone formation in New Jersey, they most probably reappear in the marble quarries distant from twelve to fourteen miles north-west of Philadelphia—a range of nearly three hundred miles.

There is a bed of magnetic iron ore, from eight to twelve feet thick, wrought in Franconia, near the White Hills, New Hampshire; a similar bed in the direction of the stratification six miles north-east of Philipstown on the Hudson river, and still following the direction of the stratification, the same ore occupies a bed nearly of the same thickness at Ringwood, Mount Pleasant and Suckusanny in New Jersey, losing itself as it approaches the end of the primitive ridge near Blackwater; a range of nearly three hundred miles.

Instances of the same, occur in the transition and secondary rocks; as the Blue Ridge, from the Hudson river to the Dan river, consists of rocks of much the same nature and included in the same formation.

That no volcanic productions have yet been found east of the Mississippi, is not the least of the many prominent features of distinction between the geology of this country and that of Europe; and may perhaps be the reason why the Wernerian system so nearly accords with the general structure and stratification of *this* continent.

It is scarcely necessary to observe, that the country must be considered of the nature of the first rock that is found in place, even should that rock be covered with thirty or forty feet of sand or gravel, on the banks of rivers or in vallies; for example, the city of Philadelphia stands on primitive rock, though at the Centre Square, thirty or forty feet of sand and gravel must be penetrated, before the gneiss rock, which ascertains the formation, is found.

ALLUVIAL CLASS.

At the east end of Long island the alluvial begins, occupying almost the whole of that island. Its north-western boundary is marked by a line passing near Amboy, Trenton, Philadelphia, Baltimore, Washington, Fredericksburg, Richmond, and Petersburg in Virginia, a little to the westward of Halifax, Smithfield, Aversboro', and Parkersford on Pedee river, in North Carolina, west of Cambden, near Columbia, Augusta on the Savannah river, Rocky Landing on the Oconee river, Fort Hawkins on the Ockmulgee river, Hawkinstown on Flint river, and running west a little southerly across the Chatahouchee, Alabama and Tombigbee rivers, it joins the great alluvial basin below the Natchez.

The ocean marks the eastern and southern limits of this extensive alluvial formation; above the level of which it rises considerably in the southern states, and falls to near the level of the sea, as it approaches the north.

Tide water in all the rivers from the Mississippi to the Roanoke, ends at a distance from thirty to one hundred and twenty miles of the western limits of the alluvial: from the Roanoke to the Delaware, the tide penetrates through the alluvial, and is only stopped by the primitive ridge. The Hudson is the only river in the United States, where the tide passes through the alluvial, primitive transition, and into the secondary; in all the northern and eastern rivers the tide runs a small distance into the primitive formation: here, as in the northern coasts of Europe, little or no alluvial is found on the primitive coast.

Through the whole of this alluvial formation considerable deposits of shells are found; also a bank of shell limestone beginning in North Carolina, parallel to, and within the distance of from twenty to thirty miles of the edge of the primitive, through South Carolina, Georgia, and part of the Mississippi territory. In some places th proportion of clay, ency of the calcareous matter to be burnt for lime: large fields of the same formation are found near cape Florida, and extending some distance along the coast of the bay of Mexico; in some situations the calcareous matter of the shells has been washed away, and a deposit of siliceous flint, in which they were imbedded, is left; forming a porous flinty rock, which is used with advantage for millstones.

In the alluvial of the New Jersey, about ten to twenty feet under the surface, there is a kind of greenish blue marl, which they use as manure, in which they find shells, as the Ammonite, Belemnite, Ovulite, Cama, Ostrea, Terebratula, &c. Most of these shells, are similar to those found in the limestone and grey wacke of the transition, and equally resemble those found in such abundance in the secondary horizontal limestone and sandstone; from which it would follow, that the different classes of rocks on the continent cannot be distinguished by their shells, though the different strata of the same class may be discovered and known by the arrangement of the shells found in them.

Considerable deposits of bog iron-ore occupy the lower situations, and many of the more elevated and dividing ridges between the rivers are crowned with a sandstone and puddingstone, the cement of which is bog iron-ore.

Quantities of ochre, from bright yellow to dark brown, are found in abundance in this formation, in flat horizontal beds, alternating with other earths in some places, in others in kidneyform masses, from the size of an egg to that of a man's head; in form, resembling much the flint found frequently in chalk formations.

So great an extent of alluvial, formed at periods of time so distant, though at present and from all the examinations yet bestowed, it appears to be the same formation, may at some future period and by future observations, be found to contain rocks similar to those of the secondary class; for instance, the whole or part of the greenish blue marl with shells, found in Jersey, both the Carolinas, and Georgia, may in process of time become solid and compact, and would then under the denomination of shell limestone, enter into the secondary, as well as many of the sandstones and puddings; for a bank of sand or gravel, united by a filtration of water, which deposes either clay or limestone as a cement, cannot be different from a like formation in the secondary. Even the early depositions of lime by the evaporation of lime water, such as at Tivoli, near Rome, cannot in hand specimens be distinguished from compact limestone of the secondary class. It is probable, that those immense masses of trees, accumulated on the banks of the Mississippi and other large rivers, may be covered by alluvial beds of sand and clay, which in process of time will consolidate into the coal measures of slate and sandstone, while the mass of wood will decompose into beds of coal, and become, under the denomination of the coal formation, secondary rocks.

PRIMITIVE CLASS.

The south-east limits of the great primitive formation are covered by the north-west boundary of the alluvial formation from near the Alabama river, in the Mississippi territory, to Long island, with two small exceptions; the first near Augusta on the Savannah river, and near Cambden in South Carolina, where a stratum of transition clay slate, (shist argileux) intervenes; and from Trenton to Amboy, where the oldest red sandstone formation covers the primitive along the edge of the alluvial. From Rhode Island along the coast by cape Cod, to the bay of Penobscot, the eastern edge of the primitive is bounded by the ocean.

The north-western boundary of this extensive range, is marked by a line running fifteen to twenty miles east of Lake Champlain, twelve miles east of Middlebury, state of Vermont, west of Bennington, twelve to fifteen miles east of Hudson, along the westward of Stockbridge, twelve miles south-east of Poughkeepsie, skirting the high lands; it crosses the Hudson river, at Philipstown, by Sparta, about ten or fifteen miles east of Easton on the Delaware, and terminates in a point a few miles north of Bethlehem, recovering fifteen miles west of Trenton; on the south side of the river it passes about the same distance west of Philadelphia, eight miles east of Downingstown, ten miles east of York by Petersburg, crosses the Susquehannah, twenty-two miles west of Washington, and joins the

Blue Ridge, along the top of which is the dividing line between the primitive and transition to Magotty Gap, from thence to four miles east of the lead mines at Austinville, and following a south-western direction, by the Stony and Iron mountains, six miles south-east of the warm springs in Buncomb county, in North Carolina, to the eastward of Hightown on the Cousee river; and a little to the westward of the Talapoosee river, it meets the alluvial near to the Alabama, which runs into the bay of Mexico.

Besides this range, there is a great mass of primitive on the west side of Lake Champlain, having that lake and Lake George for a boundary on the east, joining the primitive in Canada to the north and north-west, and following a line from the Thousand islands in St. Lawrence, running nearly parallel to the Mohawk, until it meets Lake George as a south-west limit. This primitive runs across the Mohawk at the Little Falls, and near to Johnstown on the Mohawk, where it is covered by limestone; it occupies all the mountainous country, between Lake Champlain, the St. Lawrence, and Lake Ontario.

In general, the strata of this primitive rock runs from a north and south to a north-east and south-west direction, and dips generally to the south-east at an angle of more than 45 degrees from the horizon; the highest elevation is towards the north-western limits, which gradually descends to the south-east, where it is covered by the alluvial; and the greatest mass as well as the highest mountains, are found towards the northern and southern extremities of the north-western boundaries.

The outline of the mountains of this formation, generally consists of circular, waving, detached masses, with rounded flat tops, as the White Hills to the north; or conically waving in small pyramidical tops, as the peaks of Otter, and the ranges of hills to the south. Has the climate any agency in the forms of the summits of the northern and southern mountains? Their height does not appear to exceed six thousand feet above the level of the sea, except perhaps the White Hills; it is even probable that those mountains are not much higher.

Within the limits prescribed to this primitive formation there is found the following exception, viz. Covering part of this primitive there is a transition formation, which occupies all Rhode Island (except a small part south of Newport) and runs from Rhode Island to Boston from ten to fifteen miles broad, and by the rounded transition pebbles, which cover part of the primitive, as well as the small patches left at Pembroke township, and ten miles south-west of Newburyport, on the new turnpike, it is probable that at some former period this transition has covered the primitive considerably east of Boston, perhaps as far as cape Cod. There is also a range of secondary, extending with some intervals, from the Connecticut to the Rappahannock rivers, in width generally from fifteen to twenty-five miles; bounded on the north-east, at New Haven, by the sea, where it ends to recommence on the south side of Hudson river. From Elizabethtown to Trenton it touches the alluvial: from a little above Morrisville, on the Delaware, to Norristown, Maytown on the Susquehannah, passing three miles west of York, Hanover, and one mile west of Frederickstown: it is bounded, or rather appears to cover a tongue of transition, which occupies a progressively diminishing width, as far south as the Yadkin river, at Pelot's Mount.

This secondary formation is intercepted after it passes Frederickstown, but begins again between Monocasy and Seneca creeks, the north-eastern boundaries crossing the Potomac by the west of Cartersville, touches the primitive near the Rappahannock, where it finishes. On the north-west side, it is bounded by the primitive, from some distance to the westward of Hartford, passing near Woodbury, and recommencing south of the Hudson, passing by Morristown and Germantown, *&c.* to the Delaware; after which it continues along the transition, by the east side of Reading, Grub's mines, Middletown, Fairfield, to near the Potomac, and recommencing at Noland's ferry, runs along the edge of the transition to the westward of Leesburg, Haymarket, and the vicinity of the Rappahannock.

All this secondary, appears to belong to the oldest red sandstone formation;* though in some places about Leesburg, Reading, &c. the red sandstone only serves as cement to a pudding formed of transition limestone, and other transition pebbles, with some quartz pebbles, large beds of greenstone trap and wacke of different kinds, which covers in many places this sandstone formation, and forms the small hills, or long ridges, that occur so frequently in it.

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* The oldest red sandstone family or formation in most places in Europe where I have seen it, such as on the south side of the Vosges, the south of the Alps, Tyrolian and Bohemian mountains, the south side of the Pyrenees, &c. consists of compact red sandstone, schistose red sandstone, and

The stratification in most places runs from an east and west to a north-east and south-west course, and dips generally to the north-west, at an angle most frequently under twenty-five degrees from the horizon, covering both the primitive and transition formation, at every place where their junction could be examined; and in some places, such as on the east side of the Hudson (where the action of the water had worn away the sandstone) the smooth water-worn primitive, was covered with large rolled masses of greenstone trap, to a considerable distance; the hardness and solidity of which, had most probably survived the destruction of the sandstone formation. May not similar derangements be one of the causes of the broken and unconnected state of this formation?

schistose blackish sandstone, coloured by carbon; a bluish schistose sandstone, running into wacke, compact wacke, schistose wacke, blue compact conchoidal limestone, seldom thicker than from six inches to a foot, small strata of two or three inches thick of jet, a pudding with the red sandstone for cement, greenstone and hornblende trap in ridges, and salt and gypsum. It has thus been found in Europe as above stated. All the members of this family have been found alternating with each other in the United States, except the gypsum; and there appears little reason to doubt but that more accurate research will find this likewise.

Prehnite and Zeolite are found in the trap of this formation; and considerable deposits of magnetic iron ore at Grub's mines, are enveloped, and have their circular layers intersected by greenstone trap; on a ridge of which, this extensive cluster of iron ore seems to be placed.

Grey copper ore has been found in the red sandstone formation, near Hartford and Washington in Connecticut; there are likewise mines in New Jersey, where copper pyrites and native copper have been found. The metallic veins at Perkiomen creek, containing copper, pyrites, blend and galena, are in the same formation, running nearly north and south across the east and west direction of the red sandstone, and a small bed from a half to three inches thick, of brown or red copper ore is interspersed, and follows the circular form of the iron beds at Grub's mines.

Besides this red sandstone formation, there is included within the described limits of the primitive, a bed of transition rocks, running nearly south-west from the Delaware to the Yadkin river, dipping generally to the south-east, twenty-five or more degrees from the horizon; its width is from two to fifteen miles, and it runs from the west of Morrisville to the east of Norristown, passes Lancaster, York, Hanover, Frederickstown, Bull-run mountain, Milton, foot of Pig river, Marlinsville, and finishes near Mount Pilot, on the Yadkin river. Between the Delaware and Rappahannock it is partially covered by the red sandstone formation, and is in the form of a long wedge, the thick end touching the Delaware and the sharp end terminating at the Yadkin river.

This range consists of beds of blue, grey, red, and white small grained transition limestone, alternating with beds of grey wacke and grey wacke slate, quartzy granular rocks, and a great variety of transition rocks. Much of this limestone is intimately mixed with grey wacke slate, others containing so great a quantity of small grained sand as to resemble the dolomite, and in many places considerable beds of fine grained white marble, fit for the statuary, occur.

Limespar runs in veins and detached masses through the whole of this limestone formation; and both it and the grey wacke slate contain quantities of the cubic pyrites. Galena has likewise been found near Lancaster, and many veins of the sulphat of barytes traverse this formation, which runs about twenty-five to thirty miles south-east, and nearly parallel to the great transition formation.

A similar formation about fifteen miles long, and two to three miles wide, occurs on the north fork of Catawba river, running along Linnville and John's mountain near to the Blue Ridge; and a bed of transition rock, commencing on Greenpond mountain, New Jersey, runs through Suckusanny plains, increasing in width as the primitive range decreases, joining the great transition formation between Easton and Reading.

On the west side of this partial transition formation, from the Potomac to the Catawba, between it and the great western transition range, a series of primitive rocks intervenes, something different from the common primitive, having the structure of gneiss, with little mica, the scales detached and not contiguous, or much feldspar, rather granular than chrystallized; mica slate, with small quantities of scaly mica; clay slate, rather soft and without lustre, the whole having a dull earthy fracture and gritty texture, partaking of transition and primitive, but not properly belonging to either. This rock is always found on the edge of the primitive, before you come upon the transition, but no where in such quantities as in this range. There is great variety in the appearance of this rock, an imitation of almost every species of the common primitive rocks, but differing from them by having a dull earthy fracture, gritty texture, and little or no chrystallization.*

About ten or twelve miles west of Richmond, Virginia, there is an independent coal formation, twenty to twenty-five miles long, and about ten miles wide; it would not be far distant from the range of the red sandstone formation had it continued so far south; it is situated in an oblong basin, having the whitish freestone, slaty clay, &c. with vegetable impressions, as well as most of the other attendants of that formation. This basin lays upon and is surrounded by primitive rocks. It is more than probable, that within the limits of so large a mass of primitive, other partial formations of secondary rocks may be found.

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* This class of rocks differs from the primitive, in having a less brilliant and chrystalline fracture, but corresponds with it in the direction and almost vertical position of the stratification: it differs from the transition in not containing any of those aggregates, the component parts whereof have been evidently rounded by attrition, and in the circumstance of affording no remains of organic matter, though many of the species of schist, taken separately, have a great resemblance to some of the schistose rocks, included in the transition formation. In conformity to the Wernerian nomenclature, they are here classed with th[illegible]s not coming properly under any descrip- [illegible] as transition in that system.

Granite in large masses forms but a small part of this formation, and is found indifferently on the tops of mountains and in the plains; it is both large and small grained, is mixed occasionally with hornblende and talc, and contains, as in Europe, rounded masses of a rock consisting of hornblende and feldspar in small grains, disseminated through it; it generally divides vertically into rhomboids, and, except in some very small grained, there is no appearance of stratification, when found in low situations, as in the interior of South Carolina and Georgia. It is frequently so far decomposed as to have lost the adhesion of its particles, to the depth of thirty or forty feet below the surface; each chrystal is in its place, and looks like solid granite, while you may take it up in handfuls like sand and gravel.

Gneiss extends perhaps over a half of this formation, and includes in a great many places beds from three to three hundred feet thick, of a very large grained granite, which run in the same direction, and dip as the gneiss does; it is in those beds generally where the emerald, phosphat of lime, tourmaline, garnet, cymophane, octahedral iron ore, graphic granite, &c. &c. are found. These beds are mixed, and alternate occasionally in the same gneiss, with the primitive limestone, the beds of hornblende and hornblende slate, serpentine, magnetic iron ore, and feldspar rocks. In some places this gneiss contains so much mica, as to run into mica slate; in others, large nodules of quartz or feldspar; in others, hornblende takes the place of the mica; in short, I scarcely know any of the primitive rocks that may not occasionally be found included in the gneiss formation.

It is therefore probable that geology must rest, more upon relative positions, than upon the constituent parts of rocks. For instance; the hornblende rocks which cover the red sandstone, are in many places so chrystalline, as scarcely to be distinguished in hand specimens from some of the hornblende rocks which alternate with the gneiss; it is the same with much of those small grained rocks of trappose forms, found in the primitive, compared with the transition trap or hornblende rocks found in the transition; though the latter alternate with transition slate, or what is called roofing-slate, in which the remains of organic matter have been found.

The rounded globules of feldspar and hornblende found in the great masses of granite of the Alps, in Cornwall, and in this country, could not be distinguished, in hand specimens, from the sienite of Werner, though the one is placed in the Wernerian system as the oldest, and the other among the newest, of the primitive rocks, all which proves the difficulty of establishing a line in the gradations of nature to place our artificial boundaries on; and indicates the necessity of first ascertaining the limits of the great divisions, before we attempt the specific and more minute, which would seem to require more accurate and extensive observations, than have as yet been made.

There is a compact, rather dull fractured hornblende rock, generally found on the edge of the primitive, before meeting with the transition, which is in many places mixed with epidote, both compact and chrystalline; as on the south side of Rhode Island, and along the Blue Ridge, in Virginia, &c. &c. This rock resembles the rock found in the harbour of Penzance in Cornwall, and not unlike the rock of the Lizard in England. From its appearing here always on the edge of the primitive, it is probably one of the last members of that class.

No gypsum has yet been found in the primitive of this country; nor do I think it will be ascertained to have been in place, when alternating with the primitive in Europe, having examined the gypsum near Mont St. Gothard, Mont Cenis, Coll de Tende, &c. &c. In the Alps I found it always in transition, though in one or two places that transition had slid down from the top of a neighbouring mountain into a valley of primitive rocks.

Great varieties of mineral substances are found in the primitive formation, such as garnets in the granite and mica slate, from the size of a pin's head to the head of a child, staurotide, andalusite, epidote in vast varieties and abundance, tremolite, all the varities of magnesian rocks, emerald, touching graphic granite, and disseminated in the granite of a large extent of country, adularia, tourmaline, hornblende, sulphat of barytes, arragonites, &c. &c.

From the number already found in proportion to the little research that has yet been employed, there is every reason to suppose, that in so great an extent of chrystalline formation, almost every mineral discovered in similar situations on the ancient continent of Europe will be found on this.

Metallic substances in the primitive, are generally extensive, like the formation itself. Iron pyrites runs through vast fields, principally of gneiss and mica slate; magnetic iron ore, in powerful beds from ten to twelve feet thick, generally in a hornblende rock, occupies the highest elevations, as in Franconia, the Highlands of New York, the Jerseys, Yellow and Iron mountains in the west of North Carolina. A black brown bed of hematitic iron ore in Connecticut and New York states. Chrystals of octahedral iron ore, (some of which have polarity) disseminated in granites, as at Brunswick, district of Maine, and in many varieties of the magnesian genus; black lead in beds, from six to twelve feet wide, traversing the states of New York, Jersey, Virginia, Carolina, &c.; native and grey copper ore, near Stanardsville, and Nicholson's Gap, Virginia, disseminated in a hornblende and epidote rock, bordering on the transition; molybdena at Brunswick (Maine), Chester (Pennsylvania), Virginia, North Carolina, &c.; arsenical pyrites in large quantities in the district of Maine; red oxyd of zinc and magnetic iron ore in a powerful bed on the edge of the primitive, near Sparta in New Jersey, having a large grained marble, with nigrin or silico-calcareous titanium imbedded in it on one side, and hornblende rock on the other. This bed contains likewise large quantities of blende. Detached pieces of gold have been found in the beds of some small streams in Cabarro county, North Carolina, and other places, apparently in a quartz rock. Manganese has been found in New York, North Carolina, &c. &c. Near the confines of the red sandstone and primitive formation, a white ore of cobalt has been wrought above Middletown on the Connecticut river, and found also, as is said, near Morristown in New Jersey.

The general nature of metallic repositories in this formation, appears to be in beds, disseminated, or in laying masses; when in beds (as the magnetic iron ore and black lead) or disseminated (as the iron pyrites, octahedral iron ore, molybdena, &c. &c.) they occur at intervals through the whole range of the formation. Veins to any great extent have not yet been discovered in this formation.

TRANSITION CLASS.

This extensive field of transition rocks is limited on the south-east side from a little to the eastward of Lake Champlain to near the river Alabama, by the north-west boundary prescribed to the primitive rocks. On the north-west side it touches the south-east edge of the great secondary formation, in a line that passes considerably to the westward of the ridge which divides the eastern and western waters in Georgia, North Carolina, and part of Virginia, and runs near it in the northern part of that state and in the states of Pennsylvania and New Jersey.

This line of demarcation runs between the Alabama and Tombigbee river, to the westward of the north fork of the Holstein, till it joins the Alleghany mountains, near the sulphur spring along that dividing ridge to Bedford county in Pennsylvania, and from thence north-east to Fort Ann, near Lake Champlain, and follows the east side of that lake to Canada: the separation of the transition and secondary is not so regularly and distinctly traced as in the other formation; many large vallies are formed of horizontal secondary limestone, full of shells, while the ridges on each side consist of transition rocks. The two formations interlock and are mixed in many places, so as to require much time and attention to reduce them to the regular and proper limits. It is however probable, that to the north-west of the line here described, little or no transition will be found, although to the south-east of it, partial formations of secondary may occur.

The transition formation is generally broadest where the primitive is narrowest, and vice versa; and runs from twenty to one hundred miles broad: the stratification runs from a north and south to a north-east and south-west direction, dipping generally to the north-west, at an angle in most places under forty-five degrees from the horizon. On the edge of the primitive it deviates in some places from this general rule, and dips for a short distance to the south-east: the most elevated ground is on the confines of North Carolina and Georgia, along the south-east limits to Magotty Gap, descending towards the north-west until it meets the secondary; from Magotty Gap, north-easterly, the highest ground is on the north-west side, sloping gradually towards the primitive, which ranges along its south-eastern boundary.

The outline of the mountains of this formation is almost a straight line, with few interruptions, bounding long parallel ridges of nearly the same height, declining gently towards the side, where the stratification dips from the horizon, and more precipitous on the opposite side, where the edge of the stratum breaks out to the day.

This formation is composed of the following rocks; viz. a small grained transition limestone, of all the shades of colour from a white to a dark blue, and in some places intimately mixed with strata of grey wacke slate; limespar in veins and disseminated; in many places an intermixture of small grained particles, so as to put on the appearance of a sandstone, with excess of lime cement. This occurs in beds from fifty to five thousand feet in width, alternating with grey wacke and grey wacke slate. Near the borders of the primitive is found a siliceous aggregate, having particles of a light blue colour, from the size of a pin's head to an egg, disseminated in some places in a cement of a slaty texture, and in others in a quartzose cement; a fine sandstone cemented with quartz in large masses, often of a slaty structure, with small detached scales of mica intervening; a rock not far from the borders of the primitive, partaking both of the porphyry and the grey wacke, having both feldspar chrystals and rounded pebbles in it, with a cement of a kind of dull chlorite slate in excess; another, though rarer, with pebbles and feldspar chyrstals in a compact petrosiliceous cement, and a great variety of other rocks, which, from their composition and situation, cannot be classed but with the transition.

The limestone, grey wacke, and grey wacke slate, generally occupy the vallies, and the quartzy aggregates the ridges; amongst which is what is called the country burr stone or mill stone gritt, which must not be confounded with another rock, likewise denominated mill stone gritt, which is a small grained granite, with much quartz, found in the primitive formation. There are many and extensive caves in the limestone of this formation, where the bones of various animals are found.

Beds of coalblende, or anthracite, accompanied by alum slate and black chalk, have been discovered in this formation, on Rhode Island, the Lehigh and Susquehannah rivers; and a large body of alum slate on Jackson's river, Virginia; many powerful veins of the sulphat of barytes cross it in different places; granular, as that near Fincastle, or slaty, as that in Buncomb county, North Carolina.

Iron and lead have as yet been the principal metals found in this formation; the lead in the form of galena, in clusters, or what the Germans call Stockwerk, as at the lead mines on New river, Wyeth county, Virginia; the iron disseminated in pyrites, hematitic and magnetic iron; or in beds; and considerable quantities of the sparry iron ore in beds, and disseminated in the limestone.

This class of rocks, occupying the space between the primitive and secondary, is perhaps the first that ought to be studied and the limits fixed; as a knowledge once acquired of what rocks are transition, there can be no difficulty in distinguishing the secondary at one end and the primitive touching the other.

As nature in her imperceptible gradations from one species of rock to another, has not left any marked or distinct limits, on which to place the artificial boundaries of the different classes, it is not easy to fix with certainty the kind of rocks, at which the one class ought to begin, and the other finish; and it is probable that a long series of exact observations will be necessary to determine with accuracy that line of separation.

It is probable, that between the secondary and transition class, the *horizontal stratification* of the secondary will constitute the strongest and best defined line of separation; every stratum of rocks that is horizontal, or nearly so in its original situation, will be secondary; and those which are found near it, not chrystalline or primitive, having a regular dip or declination from the horizon, will naturally fall into the transition class. It is under this idea that the dark blue colour on the map has been used for the oldest red sandstone, while the light blue has been the mark of the secondary, because I have generally found the oldest red sandstone dipping or declining from the horizon at a regular angle though small; and at the same time having few organic remains; which agrees with the general characters of the transition: whilst in relative position on the sides of many of the range of mountains it assumes the place of the transition.

The line between the primitive and transition may perhaps be marked by the presence or absence of organic remains—or of aggregates of rounded particles, the result of former decomposition—in part, by the more or less chrystalline texture—and its approach towards deposition.

SECONDARY CLASS.

The south-east limit of this extensive formation is bounded by the irregular border of the transition, from between the Alabama and Tombigbee rivers to Fort Ann near Lake Champlain. On the north-west side it follows the shores of the great lakes, and loses itself in the alluvial of the great basin of the Mississippi; occupying a surface from two hundred to five hundred miles in breadth, and extending probably on the west side of the Mississippi to the foot of the Stony mountains.

This horizontal limestone and slate, skirt Lake Champlain about Ticonderoga and Crown Point, and for some considerable distance down the east side of the lake; seldom extending above half a mile from the edge of the water; containing some shells and flints, as on Lake Erie, and appears to be the same formation as on Lake Erie. Its greatest elevation is on the south-east boundary, from which it falls down almost imperceptibly to the north-west, and mingles with the alluvial of the Mississippi, having an outline of mountains, straight and regular. A boundary of long and parallel ranges of a gradually diminishing height as they approach to the north-west limits; a stratification almost perfectly horizontal, waving with the inequalities of the surface, distinguishes this from the two preceding formations.

Immense beds of secondary limestone, of all the shades from a light blue to a black, intercepted in some places by extensive tracts of sandstone and other secondary aggregates, appears to constitute the foundation of this formation, on which reposes the great and valuable coal formation, which extends from the head waters of the Ohio in Pennsylvania, with some interruption, all the way to the waters of the Tombigbee, accompanied by the usual attendants, slaty clay and freestone, with vegetable impressions, &c.; but in no instance that I have seen or heard of, covered by, or alternating with any rock, resembling basalt; or indeed any of those called the newest floetz trap formation.

The limestone of this formation contains irregular pieces in nodules and bands, of a kind of black flint (like what is called chert in England) scattered in all forms and directions, often resembling in colour the limestone, in which case it is with difficulty they can be distinguished; they abound on the banks of Lake Erie, on the banks of St. Lawrence, where it runs from Lake Erie, and generally through the whole stratification of limestone.

Along the south-east boundaries not far from the transition, a rock salt and gypsum formation has been found. On the north fork of Holstein, not far from Abingdon, Virginia, and on the same line south-west from that, in Greene county and Pigeon river, state of Tennessee, it is said quantities of gypsum have been discovered; from which, and the quantities of salt licks and salt springs found in the same range, so far north as Lake Oneida, there is some probability that this formation is upon the same great scale that almost all the other formations have been found on this continent; at least rational analogy supports the supposition; and we may hope one day to find an abundance of those two most useful substances, which are generally found mixed or near each other in all countries that have hitherto been carefully examined.

At Lewistown, ten miles below the falls of Niagara, the old red sandstone appears from under the limestone and other strata over which the falls roll; the same makes its appearance near the Salines in the Genesee country, which would give some probability to the conjecture, that the old red sandstone is the foundation of all this horizontal formation, and may perhaps be attached to some series of rocks laying on the primitive, on the north side of the lake.

Metallic substances, hitherto found in this formation, are iron pyrites, disseminated both in the coal and limestone; iron ores, consisting principally of brown, sparry and clay iron stone in beds; galena, but whether in beds or veins is not ascertained. The large deposits of galena at St. Louis on the Mississippi, have been described as detached pieces, found covered by the alluvial of the rivers, and of course, not in place. All the large specimens I have seen were rolled masses, which rather confirms the opinion, that they were not found in their original situation.

On the Great Kanhawa, near the mouth of Elk river, there is a large mass of black (I suppose vegetable) earth, so soft as to be penetrated by a pole ten or twelve feet deep; out of the hole so made, frequently issues a stream of hydrogen gas, which will burn for some time; and in the vicinity of this place there are constant streams of that gas, which, it is said, when once lighted will burn for several weeks. Query, if a careful examination of this place would not throw some light on the formation of coal and other combustible substances found in such abundance in this formation?

Large detached masses of granite are found laying on this formation from Harmony to Erie, and from thence by the Genesee country to Fort Ann; though in many places no granite of this kind is found in place nearer than two hundred miles at the falls of the Mohawk, or perhaps on the north side of the lakes.

From near Kingston on Lake Ontario to some distance below Quebec, the country is principally primitive, and from all the information I could collect, that great mass of continent laying to the north of the 46th degree of latitude for a considerable distance to the west consists mostly of the same formation: from which it is probable, that on this continent, as well as in Europe and Asia, the northern regions are principally occupied by the primitive formation.

The foregoing observations are the results of many former excursions in the United States, and the knowledge lately acquired, by crossing the dividing line of the principal formations in twenty-five or thirty different places, from the Hudson to Flint river; as well as from intelligent men, whose situation and experience made the nature of the place, near which they lived, familiar to them; nor has the information that could be acquired from specimens where the locality was accurately marked, or the remarks of judicious travellers, been neglected.

Notwithstanding the various sources of information, much of the accuracy of the outlines of separation between the formations must depend on rational analogy; for instance, between Magotty and Rock-fish Gaps, a distance of upwards of sixty miles, I found in six different places that were examined that the summit of the Blue Ridge divided the primitive and the transition formation. I concluded of course, that in places where I had not examined (or which from their nature could not be examined) that the Blue Ridge, from Magotty to Rock-fish Gap, was the boundary of the two formations.

In adopting the nomenclature of Werner, I do not mean to enter into the origin or first formation of the different substances, nor into the nature and properties of the agents that may have subsequently modified and changed the appearance and form of those substances. I am equally ignorant of the relative periods of time, in which those modifications and changes may have taken place. These speculations are beyond my range, and pass the limits of my inquiries. All that I mean by a *formation*, is, a mass of substances (whether adhesive, as rocks, or separated as sand and gravel) uniform and similar in their structure and relative position, occupying extensive ranges with few or no interruptions of the rocks belonging to another series, class, or formation; and when such partial mixture apparently takes place, a careful examination will seldom fail to explain the phenomenon, without injuring the general principle, or making it a serious exception to the rule.

In the account of the metals and minerals, it is not intended to give a list of the number, extent, and riches of the metallic and mineral repositories; the nature of the ore or mineral, with a description of its relative position in regard to the surrounding substances, is the principal object of geology, which cannot be understood by microscopic investigations or the minute analysis of insulated rocks and detached masses; it would be like the portrait painter dwelling on the accidental pimple of a fine face; the geologist must endeavour to note the great and permanent outlines of nature, and get acquainted with her general laws, rather than study her accidental deviations, or magnify the number and extent of the supposed exceptions which must frequently cease to be such when accurately examined.

CHAPTER III.

Hints on the Decomposition of Rocks, with an Inquiry into the probable Effects they may produce on the Nature and Fertility of Soils.

Rocks in their natural hard and compact state afford little or no nourishment to vegetables; it is only in their state of decomposition and dissolution, that they become useful or necessary to the growth of plants.

The greatest part of the substances which constitute most soils, proceeding immediately from the decomposition of the rocks surrounding or laying under them, it follows of course that those soils must be materially affected by the nature and quality of those rocks: first, by the peculiar mode of their decomposition and dissolution into earth or liquids, and secondly by the nature and qualities of those earths and liquids in the formation of soils, and as food for vegetables. We shall now consider their mode of decomposition.

1st.—The mode of decomposition by dissolution in water, as limestone and gypsum.

2dly.—Rocks, which though not soluble in water, yet contain something which facilitates the solution of earths, as alkalies, &c. such as feldspar, mica, volcanic rocks, &c.

3dly.—Rocks which decompose into small, minute particles, such as argillaceous slate, hornblende, talc, and serpentine.

4thly.—Rocks which decompose only by trituration, such as flints, quartz, &c. and those which contain siliceous matter as a component part of their aggregates, such as granite, gneiss, &c.

It has been generally supposed that vegetables cannot absorb any earth in a solid state, and that solution was necessary to render any substance fit for the food of plants. Those earths, therefore, that remain in a solid state, and are indissoluble by the common fluids, most probably act only as a medium through which the plant may receive the proper proportion of the two great causes of vegetable growth, heat and moisture; two fluids, positively necessary for the support of vegetable as well as animal life, neither of which could exist without a certain quantity of heat and moisture. This is proved by the total sterility of the polar regions and the tops of high mountains from the deficiency of heat, and of the deserts of Arabia, Africa, &c. from the absence of moisture.

Earths, as a medium through which the plants may be supplied with their necessary quantity of fluids, may act in various ways; first, as a soil easily reduced by tillage into a moveable mass offering the least possible resistance to the roots of plants, when in search of their food, and at the same time facilitating the circulation of such fluids as are indispensible to their growth, as absorbents of heat and moisture. Earths as well as rocks, differ greatly in their capability of receiving more or less of those necessary fluids, because they vary in their property of retaining one or both of them, for a longer or shorter time.

Earths as well as rocks may injure materially the fertility of the soil, by allowing one or both those fluids to filter through them, thereby depriving the plant of its necessary portion. In the same manner, rocks as a sub-stratum may be useful or beneficial to the plants which grow on the surface, by their greater or less capacity of retaining the necessary fluids, as Fabroni has shewn.

It may be proper to mention here, that the effect either of rocks in their compact state as rocks, or in their decomposed state as earths, forming the soil, is the only subject of these hints or observations; and that all artificial or accidental additions of animal or vegetable matter in a decomposed state, must be considered as exceptions of the general results. Whether these decompositions of vegetable or animal matter have been scattered over the surface by the annual fall of the leaves of the forest, and decay of animal or vegetable matter—or whether the floods of rivers have covered the lower ground with their fertilizing vegetable mud—or whether the industry and ingenuity of man has strewed it over the soil as manure—the results of all such additions must be considered as foreign to the present subject, excepting inasmuch as the properties of the original soil may conduce to retain and prolong the advantages of this adventitious cause of fertility.

When a farmer clears the land of the United

States under the trees, he finds a stratum of black vegetable mould, more or less thick in proportion to the original properties of the soil, the time that the trees have been dropping their manure upon it, and the declivity which obstructs or facilitates its washing away; for this mould is lighter than water, and runs off rapidly from the sides of hills, and seldom or ever lays long on the steep descents of mountains.

While this bed of vegetable mould remains, the labour of the farmer is rewarded by rich and abundant crops; for when he sows and reaps from such a soil, four or five years before he exhausts it, he not only expends as many years' natural productions, but he consumes as many hundred or perhaps thousand years' accumulation of natural manure, which would require a very long time for the common operations of production and decomposition to replace.

It is therefore the peculiar interest of all farmers in America, to be sparing of this natural manure, and to make it last as long as they can, which may perhaps be best effected by preventing as much as possible its washing away with the rain,* a much greater proportion run-

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* The quantum of vegetable mould in a soil has been considered as a criterion of its richness. To ascertain it, a chemist dries perfectly a given quantity and weighs it; after which he exposes it to a red heat, and weighs the residue; the difference between the two weights is considered as the quantity of vegetable matter lost by combustion, and of course the measure in a great degree of its fertility.

Where this vegetable mould is not more than three to four inches thick, perhaps ploughing it in like stable maning off with the water than is consumed by the production of the vegetables raised on it.

While this vegetable mould is in sufficient quantities on the surface, the lands are more or less fertile, independent of the nature of the earth on which it lays; it is when that coat of manure is gone, and the land worn out by constant cropping,* that the soil shews its fertility, as depending on the nature of the rock of the country, and species of earth or loam, resulting from their decomposition. It is at that time that the difference between a granite and limestone soil appears, and where any one can see the effects, though few ever think of inquiring into the cause; yet it is evident that the washing and decomposition of a granite soil, can only afford sand mixed with a small proportion of sand or clay, from the mode in which the rocks divide in their process of decomposition; and even this small quantity is liable to filter through the interstices left in the aggregates of gravel, by the form of their chrystalline particles.

The limestone, on the contrary, by its easy solution and facility of decomposition, furnishes

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nure, by ploughing a little deeper might be one means of keeping it from washing; as this process would cover it with a part of the soil, which from its weight would not be so easily washed away.

* A great deal of the soil east of the Alleghany mountains does not produce now much more than one half it did when first cleared, which is probably one of the causes why the surplus produce of the United States for exportation is not now greater, if so great, as it was twenty years ago, though the quantity of land under culture, as well as the population that tills it, is almost double.

to the exhausted soil, with every rain, a quantity of food, fitted by solution for vegetable absorption, as well as a great quantity of mould divided and triturated into impalpable powder, which forms an excellent pabulum through which the vegetable can receive the other fluids necessary for its growth. Meantime this mould forms a retentive base or soil, which prevents the filtration of the smaller particles, and even retains the water in its pores, so as to give it out by regular evaporation to the surface, when necessary for the increase and support of the plants that may be sown on the land.

Beside the division of rocks into those which dissolve in and easily mix with water, as their mode of decomposing, and those which are insoluble in water, this last species of rocks are divided by their mode of decomposition into chrystalline, and deposition rocks ; because when changing from the solid rock into earth or soil, they follow a different process which produces different effects.

First, the chrystalline rocks are composed of an aggregation of chrystals of various substances interwoven and adhering together by the laws of attraction. Such rocks generally begin to decompose by a disunion of the different chrystals, and a destruction of their adhesion; then they fall into a mass of angular particles like a bed of gravel, and form a filter, through which all fluids pass more or less rapidly in proportion to the size of the chrystals; after which, each chrystal, according to its nature, begins its decomposition by throwing off an exceeding thin pellicle from its surface, and this continues scaling off until it is totally reduced; all those thin scales falling into the banks of angular particles, are generally washed by the water and filter through it; so that the residue consists of a mass of such substances as do not decompose easily but by trituration, and forms a granular bed of sand or gravel according to the size of the particles.

Rocks of deposition, consisting of particles more or less minute, arising from the decomposition of other rocks, when aggregated into a mass and fixed either by a cement or by juxtaposition, are subjected to laws of decomposition different from other rocks ; for when the adhesion of their particles is destroyed, they fall immediately into a state of earth more or less pervious to fluids, according to the nature of the particles; which being the result of a former decomposition are minute, and when pressed together by their own weight, form a mass which does not permit the fluids to pass in such quantities as to carry along with them the finest particles, and of course are not subject to wash away by filtration, like the remains of chrystalline rocks, though perhaps more easily carried off by the water from the steep sides of the hills.

All rocks which divide in the trappose form into parallelopipeds, not by chrystallization, but by shrinking or retraction from the loss of heat or moisture, fall into considerable square masses, and decompose by first losing their corners and approaching the round form, constituting a part of the rounded pebbles found in our fields; which are not rounded by attrition of water or any other cause of movement, but by the general mode of decomposition of homogeneous rocks.

It may perhaps be considered as a general principle that the farther the agents of decomposition can penetrate into rocks, insoluble in water, the greater will be the quantity that they will decompose in a given time; and the quicker that decomposition into minute particles is effected, the smaller will be the quantity washed away by the rains, and of course the necessary thickness of the soil for the production of vegetables will accumulate more rapidly; this must depend on the hardness and compactness of the rock, and all rocks of the slaty or the schistose form must be more easily reduced into soil, than those in a solid mass.

Rocks of easy decomposition into minute particles, accumulate a thickness of soil sufficient to prevent the filtration of any small particles that may be added to it, and form a bottom capable of holding what it obtains; on the contrary, rocks which in the first stage of decomposition fall into granular pieces of an angular form, leaving spaces through which all minute particles (produced by the slow decomposition of hard or chrystalline rocks) can filter along with the water, form no bottom or foundation for the accumulation of soil fit for vegetable production, but remain dry and steril; it is only on the lower ground of such countries that soil can accumulate.

To the foregoing general principles of the decomposition of rocks, there will be many exceptions when compared with actual results, arising from local observation and experience; and those exceptions will be in proportion to our deficiency in the knowledge of the various modes of working which nature employs, and our ignorance of the variety and nature of the new mixtures and compounds formed by all changes resulting from a natural process.

Great allowance must likewise be made for the action of water; for example, a river rises in a secondary country, and after traversing through limestone and other secondary rocks some hundreds of miles, it flows through a primitive country, carrying with it all the gravel and mud it has collected; it follows of course, that soils, formed of such depositions, though in a primitive country, must partake of the properties and fertility of a secondary soil, as the decomposition of limestone gravel, giving off a coat of decomposed limestone every year, will keep up the soil; on the contrary, rivers running through secondary countries, after having long flowed over primitive, will carry along with them primitive sand and gravel that will partake of the properties of primitive soils, though formed in secondary countries.

After examining some of the effects that would most probably be produced on the soil, by the decomposition of the different classes of rocks, we shall endeavour to apply the principles to the soils of the United States, in reference to the accompanying map.

The primitive, or chrystalline class, is not favourable to the forming of soil fit for vegetation.

1st. It has no remains either of vegetable or animal matter.

2dly. It is slow to decompose, and easily washed away.

3dly. It is generally situated on higher elevations, owing in some degree to its difficult and slow decomposition.

4thly. There is little or no calcareous earth in the primitive; the strata found occasionally in the gneiss, mica slate, &c. are seldom more than from twenty to one hundred feet in thickness, and do not affect much the surrounding soils.

5thly. The particles of chrystals are so minute and so compactly placed by the laws of affinity, that they absorb little or no moisture.

6thly. For the same reason they are perhaps bad absorbers and still worse retainers of heat; which may be one cause why primitive soils are so cold.

7thly. They have no gypsum in them, and very little of any other rock, soluble in water.

8thly. They have no carbon or any species of coal in their stratification, though coals are often found in the secondary basins they enclose.

The first primitive rock is the granite, which is a granular aggregate of chrystals, decomposing into a gravelly mass: this rock proceeding slowly through the other stages of decomposition, is liable to run off through the filter, or wash down the declivity.

Gneiss, from its fissile structure and additional quantity of mica, is of easier decomposition, not quite so easily washed, and forms a soil a little more argillaceous.

Mica slate has still more argil in it, and decomposes more rapidly.

Clay slate in general forms a tough strong soil, and retains the little it receives.

The accidental beds of limestone, hornblende, and serpentine, found in the three last mentioned rocks, are so small and partial, as not to affect the general nature of the soil, though their almost perpendicular position brings the edges of all the stratifications of the above mentioned rocks to the surface, and thereby renders a mixture of their component parts almost a certain consequence of their decomposition. This is one advantage the primitive has in common with the transitions, as it is more than probable that such a mixture would form a better soil than the decomposition of any one of the different strata, if isolated by being in a horizontal position; for this would confine the formation of soil to the decomposition of the uppermost stratum.

The hornblende rocks, either compact or slaty, often have small particles of pyrites scattered through them, which hastens decomposition into fine red mould, perhaps the best soil of all the primitive rocks.

Serpentine, as well as the greatest part of the magnesian genus, though decomposing easily with a stiff clay, is nevertheless unfriendly to vegetation; perhaps from the soil being so strong and adhesive as to prevent the vegetable roots from penetrating; in that case, sand might be a good manure.

Whether it is from the elevation in height, rigour of climate, or from the various other defects before mentioned, it may be safely laid down as a general position, that the primitive is covered with a soil less productive than the other classes of rocks, and serves as a foundation for much of the steril regions of the north, as well as the burning sands of the deserts.

The rivers of this class roll over precipices and rocky beds full of obstructions, scarcely admitting any continued navigation. So, when the primitive touches the ocean, it forms what is called a bold shore with perpendicular precipices, deep water, and harbours free from banks, or any other obstructions from the alluvial class.

Abundance of fine springs of clear good water, more free from all the impurities of foreign substances than in any other of the classes, are found in this class of rocks; which at the same time are generally healthy and favourable to human existence.

Quartz in small chrystalline particles being a constituent part of this class, it is of course from the decomposition and minute trituration of this quartz by the action of currents of water or wind, that we obtain the greatest part of our siliceous sand. Great masses of rocks, in rolling, form an impalpable powder, but do not form sand. It is this class that may be supposed to furnish the materials for the formation of all the aggregates of the three following classes, except perhaps the limestone, and the remains of vegetable and animal matter.

TRANSITION CLASS.

The greatest part of the rocks of this class decompose into soils favourable to vegetation.

1st. They are composed of particles, previously the result of the decomposition of other rocks; and are more easily and rapidly turned into soil.

2dly. They contain some remains of vegetable and animal matter.

3dly. With a few exceptions of those that are near the primitive, they consist either of limestone, or of rocks that have some quantity of lime in their composition.

4thly. They contain large beds of gypsum.

5thly. Being aggregates of minute rounded particles, they permit the absorption of heat; and not being good conductors, are useful in retaining it.

6thly. They absorb moisture and retain it.

7thly. They are subject, though in a less degree, to one disadvantage attending the primitive, that is, they occupy high and broken countries.

8thly. This class holds considerable masses of anthracite, and other rocks containing carbon.

The sandstone of the transition class, is difficult to decompose, and consisting for the most part of silex, makes a light gravelly soil; the greatest part of the rolled pebbles in the alluvion of this class, are sandstone.

Two kinds of aggregates are found in this class, one having a base of a greenish slate, with chrystals of feldspar and rolled pebbles, and another consisting of rounded masses of a light blue quartz, in a fibrous cement; both of these are near the primitive, and partake of its qualities, that is, decompose slowly into a sand or gravel.

Grey wacke decomposes likewise into a sand or gravel; but the cement, consisting of clay and lime, forms a considerable part, and makes a tolerable soil.

Grey wacke slate of all kinds, consisting of small rounded particles, imbedded in a considerable quantity of clay mixed with lime, and generally alternating with strata of limestone, from one inch to one hundred feet thick, decomposes into a fine loam, favourable for vegetation.

Limestone, which is found in large and extensive fields in the transition class, is likewise favourable to the formation of a good soil; but is subject to the inconvenience of forming caves, and allowing much of the water which falls on the surface, to filter through, and form little streams under the surface, which deprives the soil of its necessary moisture. This is sometimes prevented by the alternation of the grey wacke slate, which stops the circulation and throws the water out to the surface. Hence it is probable, that the alternation of the grey wacke slate with the limestone, will form a more productive soil, than when the limestone is in great masses and extensive fields.

This class generally covers the primitive, and is often found on the flanks of steep mountains, of course liable to wash, and leave the rocks bare of soil; but when it is found in low and level situations, it decomposes into a mould easily wrought and favourable to vegetation.

Being in the vicinity of mountainous and broken countries, the rivers run through it rapidly; it is therefore unfavourable to navigation.

The water is tolerable, but not so pure as that of the primitive class, holding often a small quantity of lime or salt in solution; but it is much purer than the limestone water of the secondary class, the limestone of which dissolves in water more easily and in much greater quantities.

This class, placed between the primitive and secondary, partakes of the properties of both. It has the advantage of consisting of rocks formed by the aggregation of particles the result of former decompositions, like the secondary; and resembles a little the primitive in its situation and constant declination from the horizon. This regular dip or declination from the horizon, throws the edges of all the strata on the surface, which gives to the soil formed by their decomposition the benefit of a mixture, which horizontal strata cannot produce; for example, a country composed of transition slate, limestone and sandstone, alternating in strata of from one foot to one hundred feet thick, in a state of decomposition, forms a soil, which consists of a mixture of the component parts of all the three species of rocks. This will most probably be superior for vegetation to any soil formed entirely of the decomposed particles of any one of the rocks, as would be the case, if they were in a horizontal position; it is therefore probable, that the nature of the soil is more varied, and does not continue for any great distance exactly similar, as is found in the extent of barren sand, found both in the secondary and alluvial, owing perhaps to their horizontal position.

SECONDARY, OR HORIZONTAL CLASS.

This class has many properties favourable to the growth of vegetables.

1st. It is horizontal, or nearly so; forms large level plains; and drops down by plates or embankments, seldom or never precipitous, like the two last classes.

2dly. It consists of aggregations of particles, the result of former decompositions; soft and easily reduced into mould.

3dly. It contains the remains of vegetable and animal matter in abundance.

4thly. It has much limestone strata, and rocks containing a considerable proportion of lime.

5thly. It contains large beds of gypsum and salt.

6thly. Coals are principally found in this class, as well as many compound rocks containing carbon.

7thly. Being aggregates of minute rounded particles, not so compact as the transition, they have more interstices for the reception and retention of heat.

8thly. For the same reason, they absorb and retain moisture.

The oldest red sandstone is one of the principal members of this class, and partakes a little of the properties of the transition, in having a much greater proportion of cement, consisting of fine clay mixed with the oxyd of iron, and forms a good soil; the other sandstones, united by the infiltration of water with a small proportion of cement, decompose into sand, and form a dry barren soil.

Limestone, alternating with a slaty clay mixed with carbon, forms an excellent loam and good soil. Limestone by itself, in large fields, is likewise favourable to a good soil, when it does not run into caves and under-ground drainings, which deprives the surface of its necessary moisture.

Chalk decomposes into good soil, when level; but is apt to wash, and leave only a thin soil, when in hills or steep declivities.

Sand and salt are perhaps the least favourable to vegetation of all the substances of this class; and when joined together in a warm climate, form barren deserts. Where the salt water runs under the sand, and is stopped by some stratum from going further, it has a constant tendency to mount to the surface, either by capillary or some other attraction. Arrived at the surface, the water is evaporated, and the salt left on the sand, frequently preventing all vegetation, and at best producing coarse and bad grass.

Gypsum has as yet only been found in the United States in this class, though in time it is possible that great quantities will be found, as in Europe, in the transition.

The properties of gypsum as a manure, are too well known to the farmers of the United States, by an extensive and profitable application, to require any elucidation. Why so small a quantity, as a bushel to the acre, should produce such astonishing fertility, has been a matter of controversy. Some are of opinion that it acts as a stimulant, others that it attracts the moisture of the atmosphere, *&c.*; but I should be rather inclined to think, that it owes its fertilizing power to its solubility in water, the same quantity of water dissolving more of this rock than any other.

Vegetables cannot absorb any substance, unless it be in a state of complete solution; but the quantity of earthy matter found in vegetables is exceedingly small; it would therefore follow, that should that small quantity of earthy matter be presented to the mouths of the vegetable absorbents in a complete state of solution, they would take up as much as was necessary for the future developement of the plant, and would only require afterwards the free access of the fluids of heat and moisture, which contribute so much to vegetable growth and production. Now this quantity of earthy substances, is furnished by the small quantity of the powdered gypsum thrown over the plant, which dissolving by the first rain or even dew, carries what is necessary to the mouths of the absorbents, and in this manner supplies the plant with all the earthy particles necessary for its future growth.

There are two negative proofs in favour of this supposition; first, that gypsum when burnt, loses the greatest part of its fertilizing powers, and at the same time is deprived of its property of easy solution; whereas limestone, when burnt, is of easy solution in water, and forms good manure, but in its natural state is not so easily dissolved in water, nor is it nearly so good for vegetable production; in both cases their utility as a manure appears in the direct ratio of their solubility in water.

The same theory is confirmed by the limestone land, being more favourable to the growth of vegetables, than soils produced by the decomposition of siliceous clay rocks; and perhaps for the same reason, that is, the solubility of limestone, which, though a better manure when burned, because more soluble in water than in its natural state, yet even in its state of limestone rock, it is more soluble in water than those rocks composed of siliceous or argillaceous earths.

It may perhaps be found that artificial composts, used as manure, derive part of their fertilizing qualities from the salt and alkalies they contain, having the properties of facilitating the dissolution of the different earths, and reducing them to a state of liquidity, capable of being absorbed by the vegetable as food, and of course accelerating its future growth.

The doctrine of stimulants may perhaps be applied to vegetable as well as animal life; but even in animals their common food is the principal stimulant they take, and it is probable that stimulant without nourishment is only applied in a diseased state, and when often applied to a healthy subject, will create a state of disease that will require a continuance of their irritating effects.

The supposition, that the gypsum acts as the healthy stimulant of the food of animals, both as a stimulant and nourishment to the vegetable, is perhaps carrying the analogy of animal and vegetable life as far as our present knowledge of the nature of both will admit.

As all substances used as manure for land, are bulky, and cannot bear the expense of land carriage any distance, the advantage of an easy river navigation is inappreciable to agricultural pursuits; this advantage is one of the most valuable attached to the secondary class of rocks, which from their horizontal position and small elevation, permit the rivers to run slowly over deep and unobstructed beds nearly from their sources to the ocean; so that all the small ramifications of the inferior streams can transport limestone, coal, gypsum, *&c.* to the door of every farm house, and carry away his surplus produce to market on easy terms.

This horizontal position, by allowing only one of the strata to appear, is the cause of large tracts of country being covered with the same kind of soil, the result of the decomposition of the same kind of rocks. Nothing but lowering or raising the level to the full thickness of the strata can change it; which is unfortunate where a sandstone is at the surface, decomposing into vast regions of sand; which, if it had been mixed with the strata of slaty clay, that might perhaps be found under it, would form good soil. This class of rocks falls or rises by plateaus, with large fields of table land, in general having a soil very different from each other, because they are formed from the decomposition of rocks of a very different nature.

Springs of water are of very different qualities in this class of rocks, depending on the nature of the strata through which they filter. Those which pass through sandstone, have the best chance of being purest; slaty clay, and all those argillaceous rocks that accompany coals, are often saturated with the neutral salts of copperas or alum, the result of the decomposition of pyrites which they often contain, or of common salt. The limestone of this class is so easily dissolved in water, that the greatest part of the water that traverses the limestone of it, is fully impregnated with lime, and deranges materially the bowels of strangers for the first day or two that they drink it. This is so frequent a quality attending the limestone in a horizontal position, or secondary limestone, that it may perhaps be considered as one of the characteristic properties, by which to distinguish it from the limestone of the primitive or transition class.

ALLUVIAL CLASS.

This class consists of every thing that is washed from all the other classes and deposited in beds, either from the waves of the sea, or of lakes, the currents of rivers, of winds, &c.

It possesses the advantage of being nearly level, and not subject to wash.

When deposed by the action of rapid running rivers, it is generally sand and gravel and poor soil; but where slow running rivers overflow their banks, they for the most part leave a rich vegetable mould, making a fertile soil.

The sea most usually agitated, leaves sand or gravel on its shores, which is likewise the case with the great lakes; this seldom forms a good soil.

In this class we find the greatest quantity of marshy soil, rich in vegetable production, but difficult to drain, on account of its low and unhealthy situation.

Marle is one the best depositions for making good soil, and is generally found in alluvial situations by the sediment of rivers that have run through limestone countries. The gravel deposited by rivers, which run through a limestone country, decomposes into good soil, and may be called a limestone soil; but the depositions of sand and gravel, from rivers running through primitive countries, partake of the qualities of primitive rocks, and form but a dry, light soil.

Extensive plains of sand are often found in the alluvial formed by the sea; these frequently change place by the wind, and form a series of small hills, covering in many places large tracts of low country, which it renders barren and unfit for production.

Inland navigation in this class is extensive and commodious, the rivers running slowly and smoothly over deep beds, renders them navigable to near their sources. The navigation from the Caspian sea to the Baltic, by the Wolga and the Neva, carries boats upwards of one hundred tons burthen, with only one canal of about a mile long to join the two rivers, there being only four feet difference of level between them; all which long navigation, is through alluvial for the greatest part of the distance. That junction of the waters of the Black sea and the Baltic, by river navigation across Poland, is likewise through an alluvial country. The internal navigation of alluvial countries is generally good; but where the alluvial forms a sea coast, the harbours and bays are difficult and dangerous, obstructed with sand banks and shoals.

From the nature of the aggregation of alluvial materials, they generally consist of a considerable mixture of different substances, yet from its horizontality, it sometimes contains extensive tracts, covered with soil of the same or similar depositions, being the result of the same causes, such as the sand thrown up by the action of the waves of the sea, *&c.*

The alluvial of small vallies, situated in broken and mountainous countries, has a much better chance of being rich and fertile than of large vallies in level countries; because in proportion to the extent of the surface, they receive the washings of a much greater extent of soil, than those large vallies in level countries can possibly receive from surfaces whose horizontal position prevents their washing. It is from this cause, that the few small vallies, found in primitive countries, are so rich, and form so great a contrast with the soil of the mountains.

TRAP CLASS.

This class, though exceedingly limited in extent, generally lays over all the others, and occupies the tops of hills.

1st. It is of difficult decomposition, being hard and adhesive, but falling easily into trappose pieces.

2d. It is capable of absorbing and retaining moisture, resembling in a small degree lava, being full of very small interstices.

3d. It is equally capable of absorbing and retaining heat.

4th. Being a partial and scattered class, it is mixed, and covers all the rocks of the other classes, and of course, in the formation of soil, partakes of their quality.

The basalt of this class decomposes slowly, but forms a good soil, where it does not wash. The wacke and porphyries decompose into strong clay soil, capable of retaining the manure put into it, and in low situations form a tolerable soil.

Tuffa, and other loose aggregates of this class, partake of the nature of volcanic rocks when decomposed, and form excellent soils.

VOLCANIC CLASS.

This is a partial, irregular, and variegated class, and has many properties highly favourable to vegetation in its decomposed state.

1st. From its origin it generally occupies elevated situations.

2d. It contains from one-twentieth to one-tenth of alkali, which favours its decomposition, and perhaps its dissolution.

3d. Though hard, and often chrystalline, yet it is in some places full of pores, and in general has innumerable small interstices, which both absorb and retain moisture.

4th. For the above reason it both absorbs and retains heat.

Lava, when compact and approaching the vitrified slate, is exceedingly slow of decomposition; but when decomposed in low places, it forms a rich soil; the fuller it is of pores, the more easily it decomposes, and of course makes the soil deeper and more productive.

All kinds of volcanic ashes, with all kinds of tuffas, form fine rich mould, and in a short time equal in thickness the bed of ashes or tuffa; the fertility of such a soil is inexhaustible.

From the foregoing investigation it may perhaps be concluded, as a general result, that the oftener rocks have undergone decomposition and trituration into minute particles, the more fit they are to produce and support vegetables; and the more frequently they have been moved from one place to another, by the agents of decomposition, the more plain and level is the situation they are left in: after every change, this may be traced from the primitive through the transition and secondary to the alluvial; the surface of the decomposition, after such change, becoming less steep and precipitous, approaching nearer and nearer to a level, fit for the reception and retention of all matter, both fluid and solid, capable of assisting vegetable growth.*

To the above general result, the trap and volcanic, or what some would call the old and new volcanic formations, are exceptions as to situation; being thrown from an opening in the surface, the matter ejected must accumulate round the mouth of the crater and its vicinity; and the oftener it is remitted and ejected, the higher will most probably be the mountains it forms, and of course less fit for the production of soil and situation favourable to the growth of plants; this is one of the striking contrasts between the Neptunian operations and the volcanic, that are daily going on under our eyes; rains and rivers wash down the mountains into the plains, while fire heaps up the plains into high and precipitous mountains.

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* In aid of nature's operations to reduce the particles of earth to a state more fit for vegetable production, comes the industry and ingenuity of man, by digging, ploughing, harrowing, and manuring; they much accelerate the progress of ameliorating the earth's surface, and thus accomplish in a few years of labour judiciously applied, what nature would require many centuries to effect by operations of her general laws.

The perfection of all the arts, therefore, only prepares the means of a more rapid and certain progress towards perfection, and who can fix the limits where it shall stop?

Considering that the action of fire is but partial, and the action of water constant and general, the prospect into futurity is consoling and cheerful; that the earth is every day moulding down into a form more capable of producing and increasing vegetable matter, the food of animals, and consequently progressing towards a state of amelioration and accumulation of those materials, of which the moderate and rational enjoyment constitutes great part of our comfort and happiness. On the surface of such an extensive and perpetual progression, let us hope that mankind will not, nay cannot, remain stationary.

On looking back to the probable past, without going so far as to interfere with any of the present general laws of nature, it may occur, that before all this alluvial, secondary or transition had been rolled about, pounded up and mixed by the rains and rivers, united with the various operations of vegetable and animal production, the state of this earth most probably was different, when the first lichen began to accelerate the progress of decomposition on the surface of the first rock.

CHAPTER IV.

The probable Effects, which the Decomposition of the various Classes of Rocks may have on the Nature and Fertility of the Soils of the different States of North America, in reference to the accompanying geological Map.

It may be necessary again to say, that these observations are only adapted to the earthy part of soils, and are not applicable to soils where the operations of nature in covering the surface with the decomposition of vegetable and animal matter, or the industry of man in putting manure, has mixed the soil with a considerable quantity of vegetable mould. Such soils are productive so long as the vegetable mould remains. The earth formed by the decomposition of the rocks, or the rocks in their original state, are only accessory to the production of this mould, in proportion to their quality of producing a more or less quantity of vegetables, and their property of retaining the vegetable mould a greater or less period of time.

Over the extended surfaces which one class of rocks covers, some considerable exceptions to general rules must be expected; such as remains, or partial patches of a different class of rocks, overlaying the general stratification, and producing effects on the soil, conformable to the properties of the class they belong to. An example of this on a large scale is to be found in the Redlands, which crosses Virginia in the direction of the Green mountains, and penetrates considerably into North Carolina. These lands, though resting in many places upon a primitive formation, differ from the generality of primitive soils; they contain little or no sand, fall into impalpable powder, and I believe hold a small portion of lime; if there should be an extensive mass of hornblende rocks intimately mixed with pyrites, the decomposition of such a mixture might perhaps produce a similar soil, but such a circumstance rarely happens. It is therefore more probable, that this extensive bed is the remains of a transition formation, part of which still runs near it and under it, from the Delaware to the Yadkin. Although at present this formation is by no means so broad and extensive as the red soil, yet it might formerly have been competent to produce an alluvial of that extent. The red soil, and this narrow bed of transition, running in the same direction and always together, though the red soil covers a much greater surface at present, renders the supposition the most probable that it is the decomposition of a bed of transition limestone and grey wacke, that formerly covered a much greater surface than it may now do; or it may be perhaps a continuation of the red sandstone, which begins at Connecticut river, and finishes near the Rappahannock, with some few interruptions; or it may be a bed of alluvial, transported from a great distance by the movement of waters that have long since ceased to act. As the transition strata accompany it through its whole course, the most rational conjecture is, that it is the decomposition of a transition bed formerly more extensive than at present. In this manner many partial beds of a different class form patches over a general formation, producing soils that to a superficial observer might become a great exception to the general principle, though when accurately examined, only tend to confirm and support the general rule.

By reference to the accompanying geological map it will be seen, that the four New England states consist mostly of the primitive class of rocks, except in two places; the one from the boundary line between Vermont and Massachusetts, on the Connecticut river, south of Middletown, and from thence to New Haven, in breadth from fifteen to twenty-five miles, composed of the oldest red sandstone formation.

The second exception is the greatest part of Rhode Island, and from thence to Boston, where about fifteen miles broad of the primitive is covered by the transition class or formation, and from the remains of a few patches of transition to the east and north-east of Boston, with the beds of transition pebbles found on the primitive. In that direction it is more than probable that the transition has extended, at some former period, much farther to the north-east.

To the west the New England states, including the district of Maine, are bounded by a range of high and rugged mountains, where the vallies are very narrow, and surrounded by steep and rocky banks. Many of those vallies are fertile, being the repositories of the washings of a great surface of mountain; but the sides of the hills and mountains are bare, and retain little or no soil. Where the mica slate, clay slate, hornblende and primitive limestone prevail, the soil will most probably be more adhesive, accumulate quicker, and form a thicker bed. Where granite, gneiss, quartz, and other siliceous rocks prevail, the soil will most probably be light and thin.

From the mountains to the westward the country declines gradually to the sea coast, where there are but few hills; yet the surface is rugged and broken, obstructed in many places by large blocks of rocks, chiefly granite, heaped on the surface of a soil, rather sandy and light, which is tolerable the first four or five years after it is cleared of wood, but would require manure afterwards to make it productive.

A proper proportion of heat and moisture is requisite for the production of all plants, but the grasses require more especially moisture. It would appear that the New England states are best fitted for a grazing country, and moisture becomes more necessary for such a country, than for a wheat or Indian corn country. The clearing away the woods, favours the accumulation of heat in the earth, but decreases the quantity of vapour, that in passing would be condensed into rain. It would therefore seem to be prudent in such countries, not to clear more land than is positively necessary, and on no account to cut down the trees that crown the tops of the hills and mountains; for by baring their tops, the summer temperature will be so much increased, that the clouds will pass over them without condensing, and the effects which are produced in the islands of the West Indies, by cutting away the woods, will take place on this continent, though not in so great a degree.

Between Rhode Island and Boston, the transition will most probably be covered with a soil rather fertile, where the grey wacke schist and limestone prevail; and only tolerable, where the grey wacke with large pebbles is found, but on the whole, better than the upland of any primitive soil.

The oldest red sandstone on the Connecticut river, when level, which it generally is, ought to produce a good soil where it is covered with ridges of greenstone trap; but a gradually thin soil, where the irregular declivities and trappose division of the rock, prevents the accumulation of earth sufficiently quick to form a permanent soil.

The sea coast, is, agreeably to the general character of the primitive class, little obstructed by banks or shoals, and the harbours are open, large and commodious, of easy access, with plenty of water, and safe; but the internal navigation by the rivers is exceedingly bad, full of rocks and rapids, difficult to remove; while the hard and adhesive nature of the rock, is a great hindrance to the cutting of canals.

Where the oldest red sandstone occupies the banks of the Connecticut river, from the frontiers of Vermont to below Middletown, the navigation is tolerable, approaching a little to the advantages generally attending that class of rocks; but further up the river, in Vermont or New Hampshire, where the river runs over primitive rocks, the falls and rapids are both greater, and occur more frequently.

Vermont lays to the westward of the New England states, and occupies part of that range of mountains, running north and south in the direction of the stratification, nearly twenty to thirty miles from Lake Champlain, and parallel to it. Two classes of rocks occupy the whole state; the transition which extends along Lake Champlain, and is about twenty-five miles broad, where the primitive begins, and continues till it joins the frontiers of New England.

In the transition, the soil will most probably be good, where the land is level and composed of grey wacke schist and limestone; the siliceous members of the transition class occupying in general the mountains, will most probably be thin and sandy, though in level places the soil may be tolerable, owing to the declination from the horizon mixing the alternating strata.

The primitive, which forms the east side of the state, is principally composed of mica and clay slate, which may form a compact and strong soil in the vallies; the sides of the mountains will most probably be thin and light soil, not sufficiently thick to produce much vegetation.

Through the whole of this state, as well as the New England states, the range of the mountains runs from north to south, and of course all the vallies of any consequence follow the same direction; open to the north and north-west winds, they are equally exposed to the south and south-west, taking immediately the temperature of those two contrary currents of air. Vallies thus situated, are subject to have a very hot summer and cold winter, and also to the great evil of a vacillating spring and autumn, where heat and cold alternate so quickly, as to injure materially all vegetables, but more particularly those of foreign origin, which is the case with most of the plants that are cultivated in the United States.

To the south-west of the Hudson river this inequality of climate is moderated a little by the chain of mountains, as well as the principal vallies, running south-east,* and consequently in some measure sheltered from the sudden changes produced by the north and north-west winds in spring and fall.

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* The same difference of climate is observable between Italy and Spain. In Italy the chain of the Apennines runs nearly north and south, leaving a free passage to the northerly winds to carry their temperature into all the great vallies; but in Spain the Sierra Novada, and many of the ranges of mountains, like the Pyrenees, run from east to west, and protect all to the south of them, from the sudden variations of climate, which frequently occurs in Italy during the winter. Nice, for the same reason, is considered to have the mildest winter of any place in the south of France, being under shelter of the Alps, which run towards the east on the north side, and screen the town from the northerly winds. Tokay produces what is called the finest wines in Europe, and is only a degree south of Poland, where there is no species of wine; it owes this to the chain of the Carpathian mountains, running east and west, and protecting Hungary from the rigour of the north winds. Even the polar climate of the great plain of Tartary, may perhaps be owing to the ranges of mountains running towards the Frozen ocean, while the great vallies, through which the rivers Obi, Lena, Tenisey, &c. run their long rapid courses, may serve as conductors of the

All circulation of heavy and cumbersome articles, such as are used for manure, is exceedingly difficult in the interior of this state, as the rivers are full of falls and rapids; but Lake Champlain facilitates considerably the exportation of their surplus produce; they also have the advantage of the tide navigation of the Hudson, for taking their produce to market.

The state of New York consists partly of alluvial, and partly of primitive, transition, and secondary rocks, and enjoys a tide navigation on the Hudson river, which penetrates through the whole classes.

Long island forms the alluvial part of the state, and has all the advantages of being a low level country, which is generally attached to this class. The west end of this island is partly made up of the alluvial, washed down by the Hudson from a transition and secondary country, and may be considered as forming a soil favourable to vegetable production, where the action of the waves has not washed away the lightest and most productive part of it.

temperature of the poles to their sources, and the same chains of mountains, which by running east and west, protect Indostan from the northern blast, may equally prevent Tartary and Siberia from enjoying the vivifying influence of the southern breezes. It is probable, that much of the climate of all countries depends on the currents of air and water, and their direction is perhaps regulated by the mountains on shore, and the banks, and other obstructions at sea, as well as by periodical winds.

The east end of the island, formed principally by the alluvial of the sea, joined to a proportion of alluvial furnished by rivers, such as the Connecticut, that run through the primitive, is most probably light and sandy, with extensive beds of gravel, too poor to produce a sufficient growth of trees or plants to enrich the soil; but enjoying the advantages of an even surface, not liable to wash; and likewise the moderate and equal climate of a low island, surrounded by the sea; hence it is capable of being made productive in pasture lands, like all the islands on this coast, which are favourable to the breeding of sheep bearing fine wool.

York island, and the Highlands, as far as Newbury and Philiptown, on Hudson river to the north, and the boundaries of Connecticut to the east, is primitive. From the town to the commencement of the Highlands we find principally gneiss and granite, and of course it inclines towards a gravelly and thin soil; the Highlands as well as the primitive which skirts the Connecticut border, contains much clay and mica slate, and will most probably form a stronger soil in the vallies.

That mass of country north of the Mohawk, bounded by Lake Champlain to the east, and the river St. Lawrence to the north, is likewise primitive; and from all appearance is a rough mountainous country, with some vallies of tolerable soil; but the mountains are most probably thin and poor, subject to the northern winds, and the rigorous changes of climate, which are the natural consequences.

From Philiptown on the Hudson, to near Lake Champlain, is a strip of transition from fifteen to twenty-five miles wide on the east side of the Hudson, and extending on the west side perhaps further; though in many places west of the Hudson, on the tops of mountains and rising grounds, it is covered by secondary, forming a constant alternation between transition and secondary, which would require much accurate examination to designate; we have therefore coloured the whole as transition, which we consider the foundation.

This valley, divided by the Hudson, ought to have a good soil, where it is level, consisting principally of grey wacke slate and limestone; but is subject to the inconvenience of the Vermont vallies, in being open to the north, and liable to sudden and great changes in the temperature. The advantage of a tide navigation, running almost the whole length, is all important to the progress of agriculture, by transporting, at an easy expense, the bulky articles necessary to improve the soil.

The secondary of this state, runs along the Mohawk to Lake Ontario, and follows the borders of the lakes to the frontiers of Pennsylvania, skirting the transition to the south-east; it is generally tolerable soil, the alluvial of the rivers being composed of depositions from the decomposed secondary; is in most places rich and fertile, as on the Mohawk, &c. The alluvial of the lakes, in many places washed by the movement of the waters, is but thin and inclined to be sandy. How far the alluvial of the lakes extends to the south depends on how far the lakes themselves have covered those countries formerly; which is uncertain.

This secondary makes rather a small exception to the general rule of that class, possessing the properties of easy and safe navigation in the interior, owing to its small rivers running principally into Lake Ontario, which is so considerably below the general level of the country, that the streams are rapid and often obstructed by the falls. The communication with the sea, either by the lake and the St. Lawrence, or by the Mohawk and Hudson rivers, is but slightly obstructed with rapids and rocks. From the western part it is probable that the communication through French creek, the Ohio, and down the Mississippi to the gulf of Mexico, is perhaps the most easy and convenient passage to the sea.

A canal from Lake Erie to the Mohawk has been projected. So great a distance, across all the vallies made by all the streams, which run into the Lake Ontario, would make it an expensive undertaking; so much so, that it is probable the whole surplus produce that would pass through it would not pay one per cent. on the sum expended, in making it. The quantity of surplus produce to feed the idle, or to export to foreign countries, depends on the quantity consumed by the farmers and labourers at home. In this country, where they eat animal food, and every thing of the best kind, three times a day, the surplus produced by three or four labourers is not equal to the surplus produced by one labourer in countries where they eat nothing but brown bread and potatoes; where the labourers are slaves; where consumption is restricted to a few quarts of corn a week. In such places, the surplus produce destined to feed their masters and for exportation, is considerable. If all the produce made by the slave states, and exported by them, or through the medium of the other states, could be deducted from the whole exports of the United States, the balance exported by the free labour states, would be much smaller than most people are aware of.

While the labourer lives so well, and consumes such a great proportion of the produce of his labour, those statesmen and others who judge of the capability of this community to pay taxes, and feed the unproductive classes, from what takes place in Europe, will be much mistaken. No produce can possibly supply more to the non-productive class, than the surplus that remains to the farmer, after furnishing every thing his habits make necessary to feed himself and family; where those habits are like those of the labourers in most parts of Europe, they can furnish four times more surplus, out of the same produce, than the labourer can here with his present habits.

Jersey consists of alluvial along the sea coast, which runs along the east bank of the Delaware from Cape May to Trenton; and from thence to Elizabethtown it is bounded by the red sandstone. It is of course partly formed by the sea and partly by the depositions of the Hudson and

Delaware rivers, which touch two sides of it; the part of this alluvial, formed by the above mentioned rivers, consisting of depositions washed off the transition and secondary formations, is most probably good soil; but the part of it thrown up by the waves of the sea, will be thin and sandy.

Considerable depositions of bog-iron ore, are found in this alluvial, which may perhaps be owing to the vicinity of the old red sandstone, the iron oxyd of its cement furnishing the materials. So, the bog-iron ore is more abundant in the alluvial of Maryland and the Jerseys, where the red sandstone is found in the neighbourhood, than in other states to the south.

The oldest red sandstone extends from the edge of the alluvial to the foot of the primitive mountains, and from the Hudson to the Delaware. Where the country is level, and consists of the red sandstone only, the soil is good; where it is covered with the greenstone trap, it is generally thin soil and stony.

To the north-west the primitive range occupies the frontier of the state, diminishing in breadth as it progresses to the south-west, and finishes in a point south of Bethlehem. This primitive is rugged and steril, where the mountains are steep and precipitous, or where the quartz and siliceous rocks predominate. The slates, hornblende, and primitive limestone, where level, form a tolerable soil; it is likewise rich in fine magnetic iron ore, which has been wrought to advantage; but is deprived, like the greatest part of primitive ranges, of river navigation; a great hindrance to the progress of agriculture as well as manufactories, from which disadvantage the secondary and alluvial of this state, is in some measure free.

Pennsylvania consists principally of transition and secondary, having the smallest quantity of the primitive class of any state east of the mountains, and most probably the greatest quantity of good land, in proportion to its surface, of any of the Atlantic states.

From the south-east boundary, to about twenty or twenty-five miles north-west, is included all the primitive of the state, which is light and indifferent, where the gneiss, granite or serpentine prevails; the limestone or hornblende rocks may form a tolerable soil, as the country, though broken, is not hilly, and has nothing that can be called a mountain. The rivers Susquehannah, Schuylkill, Delaware, or any other inferior streams, where alluvial is formed, being the depositions from transition and secondary formations, will most probably produce a rich soil.

An extensive transition formation succeeds to the primitive and occupies nearly seventy miles in breadth to the top of the dividing ridge, between the western and the eastern waters, which forms the summit of the Alleghany mountains. In this place the transition is wider than in any other part of our range of mountains, and is only interrupted for about twenty or thirty miles, between Norristown and Reading, by being covered by the oldest red sandstone formation.

The soil, through the whole of this tract, when level, is tolerably good; where formed by the alluvial of the rivers, it is generally rich and fertile, but the quartzy and siliceous aggregates, which most frequently occupy the mountains, decompose into a light sandy soil, though the vallies between those mountains are rich and productive.

The river navigation of the primitive and transition of this state is, agreeable to the general character of those classes, very indifferent, obstructed by a great many rapids and falls, liable to the freshets of mountain torrents, breaking through narrow and rocky passages, with all the extremes aud inconvenience of too much or too little water, to remove which would require much labour and expense, which perhaps could only be repaid by the transportation of some very bulky articles, such as coal, gypsum, or limestone. It is a query whether an expensive canal navigation can be repaid by the mere transportation of the surplus produce of the soil, or even of manufactories, except bulky coal. Limestone, iron and manures, it is probable, support the greatest part of the expense of canals, even in England.

From the top of the Alleghany mountains to Lake Erie, is part of the great secondary formation of the basin of the Mississippi, and extends from the frontier of the state of New York to the limits of Ohio and state of Virginia; this secondary formation may incline to be sandy on the hills, where the sandstone prevails; but the valley and river alluvial is rich and fertile. It loses little of the vegetable mould by washing, owing to its general horizontal position; and the accumulation of such vegetable manure is in proportion to the time the trees have been growing on the soil. It is probable that the alluvial made by the washing of the lake, may be thin and sandy, as well as the part that may have been at no very distant period the bottom of the lake; and for that reason the trees may not have been long enough on the surface to accumulate a bed of vegetable decomposition of any great thickness; in that case, though the earthy part of the soil may be good, the natural manure, dropped from the trees, may be thin and soon worn away.

Both coal and limestone have been found in great abundance on the west side of the Alleghany mountains; the coal they use with advantage as manure; the slaty clay, which alternates so often with the limestone in this formation, contains carbon, which augments its productive quality when decomposed into soil.

Though nearly fifteen hundred miles from the sea, it enjoys a river navigation, without any siliceous obstructions, the whole distance; as the secondary extends to the bay of Mexico, and affords all the advantages of deep and slow running rivers (which is generally the character of this class of rocks) facilitating every kind of internal navigation.

From the ease with which they navigate the small creeks and streams, every farmer may have a landing place near his plantation, and receive at small expense the limestone, plaister, or coals, necessary to agriculture and the other arts. Even where a canal is necessary in this class, the level situation and nature of the rocks, makes the accomplishment of it easier than in most of the other classes.

There is no ridge of mountains on this side Lake Erie that can shelter the country from the north and north-west winds; it is therefore probable that this part of the great basin is exposed to the sudden and great changes of temperature, produced by the rapid currents of air from north to south, or from south to north; it is equally in the nature of such a situation for the changes to be more rapid and more severe, in proportion as the land is cleared of wood. Prudence might perhaps dictate the leaving strips of wood from east to west, on purpose to protect as much as possible the useful plants from the effects of the rapid changes in the spring and fall.

The state of Pennsylvania is perhaps the best cultivated of all the states in the union; that is, more of the farmers have dropped the ancient practice of wearing out one field, and going to clear away the trees of another, without adopting any system of manuring by plaister, or rotation of crops, so as to keep the lands once cleared continually in heart. Most of the Pennsylvania farmers, like the farmers in Europe, make their fields better and richer in proportion to the time they have been in culture; it is therefore partly to art and industry, and partly to nature, that we are indebted for the prosperous state of agriculture in this commonwealth.

Delaware, the smallest state of the union, consists almost entirely of alluvial; the part formed by the depositions of the Delaware, will most probably be good soil, while that made by the washings of the sea will be light and sandy. That small strip of primitive, which touches the Pennsylvania frontier, being low and level, is more or less covered with alluvial, and is likely to be tolerable soil.

The tide water of the Delaware, and small rivers and creeks in the alluvial, furnishes this state with good internal navigation.

Almost surrounded by tide water, this state has access to the sea at all points, and enjoys, from its being placed between the Delaware, the sea, and the Chesapeak, almost the mildness of an insular situation, not so subject to extremes of heat and cold.

Maryland has a great deal of alluvial, some primitive and transition, and very little secondary. The Chesapeak is the large inland bay, formed most probably by the ocean throwing up a bank of sand and gravel on the eastern shore; on the inside of which the great rivers, that now run into the bay, have been constantly heaping their depositions, consisting of the washings of a great transition and secondary country, which descend with the waters of the Susquehannah and Potomac, and the sediment of the Rappahannock and James rivers, consisting of transition and primitive deposition.

It is therefore probable, that the alluvial of both sides of the Chesapeak, protected by the neck of land on the eastern shore from the washing of the waves of the sea, will be good soil generally, and approach nearer to the quality of river bottoms, than any alluvial open to the movements of the sea, and liable to be washed by it. The situation in which we now find it, after so long a practice of so ruinous a system of culture, constant cropping, and no manure, is a strong proof of the original good quality of the soil.

Such is the nature of the alluvial in Maryland, occupying all the state south-east of a line drawn from Havre de Grace on the Susquehannah, passing through Baltimore to Washington on the Potomac. For navigation, both internal and external, the alluvial of Maryland enjoys all the advantages attached to that class of rocks, in an easy and safe access to the sea by the Potomac and Chesapeak bay, and a free circulation of craft in the interior by means of all the small rivers and creeks, through which the tide mounts to the foot of the granite ridge, that is, to the entrance upon the primitive.

This primitive begins at the line where the alluvial ends, and continues towards the north-west, from twenty to twenty-five miles; the country rugged but level; in some places thin and poor, in others tolerable, as it approaches the old red sandstone; a band of which, eight or ten miles wide, lays upon the outer edge before we come upon the transition; this band of red sandstone makes good soil, where the sandstone prevails, but rather thin and light soil, where the greenstone trap covers it.

The west part of the state is a strip along the banks of the Potomac, of transition, which is most probably good soil. So great a proportion of this state laying upon tide water, intersected by the Chesapeak, and so many bays and creeks, will probably diminish the rigour of the winter, and modify the extremes of heat and cold in the spring and fall.

Virginia contains all the classes of rocks, and like Pennsylvania stretches considerably into the secondary basin of the Mississippi. The alluvial occupies all that part of the state situated on the south east side of a line drawn from Washington through Fredericksburg, Richmond, and Petersburg, to the Roanoke, having the sea for its south-east boundary. On the northern part it is good soil, like the alluvial of Maryland, but towards the south it is partly made up of the alluvial of the ocean, and partly of the deposits brought down by the Rappahannock and James rivers, collected principally from primitive countries, mostly of sand and gravel; of course, the probability is, that the soil towards North Carolina will be sandy and thin.

Both the internal and external navigation is excellent; for the tide flows up all the small rivers and creeks to the limits of the alluvial or commencement of the primitive; and the vast influx and reflux of the tide into the Chesapeak, sweeps the channels between the capes so clear of banks, as to afford water of sufficient depth for any ship; which is rather contrary to the general effects produced on alluvial coasts.

The primitive succeeds to the alluvial, and runs north-west to the Blue Ridge, which it keeps as a boundary to Magotty Gap; from thence it proceeds south-west, and passes to the eastward of the lead mines at Austinville, and from thence towards the warm springs in North Carolina. The vallies in this, like all other primitive, are narrow, but generally rich and fertile. The upland, as far west as the South or Green mountains, is rather level, but broken; the soil thin and light near to the Green mountains; ranging in the same direction, is the red soil, which crosses the state, seldom extending twenty miles in width, or much less than six to seven miles broad; frequently irregular and in patches, and is perhaps the best upland soil, independent of river bottoms, that is in the Atlantic states.

This bed of red soil follows a narrow stratum of grey wacke slate and transition limestone, and in many places it covers the primitive at some distance from the limestone, yet it is more than probable, that it is the remains of a transition formation, which may have formerly covered the primitive to a greater extent.

Westward of the red soil, the soil is thin as long as the Blue Ridge is the boundary, to Magotty Gap; but after the ridge is primitive, to the south of Magotty Gap, there is a considerable extent of gravel, covering the foot of the ridge, called the gravel ridges, which being composed of rolled quartz, apparently the remains of a great field of clay slate, mixed with a great quantity of transition sandstone pebbles, the soil is barren and thin, producing no growth of wood sufficient to manure it. Those gravel ridges continue along the foot of the primitive mountains, through both North Carolina and Georgia.

The navigation is indifferent, though below the ridge, from the level situation of the country, boats run upon James river.

On the limits of the primitive begins the transition, which continues west of the top of the Alleghany, near the Sulphur springs; from thence south-west to the eastward of Abingdon, passing about twenty-two miles west of the Painted rock on the frontiers of North Carolina and Tennessee. This is rather a broken, mountainous country, with extensive vallies of limestone and slate, which produces good fertile soil, while the mountains, consisting principally of sandstone and quartzy aggregates, make a thin, poor soil; the navigation being bad, owing to the want of water near the sources of the rivers, and the obstructions of falls and rapids hinders equally internal circulation and external communication with a market; resembling in this, the whole country which occupies the dividing range between the eastern and western waters; that is, to be further from a market than those lands situated either east or west on a navigable river.

Between the limits of the transition and the river Ohio, is the secondary of this state, which enjoys the soil and advantages of the secondary of Pennsylvania, except as to the rivers that water it. The Great Kanhawa and other streams rise in a mountainous transition country, and may probably carry down and deposit masses of gravel, formed by the quartzy aggregates and sandstone, which frequently occupies the high lands in transition countries; whereas all the rivers in the Pennsylvania secondary, rise and run their whole course in the secondary, and are therefore more likely to make deposits, that are richer and more adapted to vegetable production.

North Carolina consists principally of alluvial and primitive, divided by a line running to the west of Halifax and the east of Raleigh, passing by Aversboro' and Rockingham. To the east of this line, extending to the sea, runs the alluvial formation. From the circumstance of this alluvial being made by the washing of the waves of the sea, or accumulated by the depositions from rivers which have run their whole course through a primitive country, the probability is, that it will in many places be sandy and thin soil.

That part of the coast bordering on Pimlico and Albemarle sounds, being protected by the sand banks and bars from the washing of the waves of the sea, may deposit a tolerable alluvial, approaching in quality to that of the Chesapeak; if the same bars and banks did not obstruct the draining of the low lands that surround those inlets, and render them too watery for the purpose of agriculture: though from the heat of the climate it is probable, when united to a sufficient moisture, the accumulation of vegetable productions will be rapid.

From this increasing heat, as we go south, a considerable increase of vegetable production must accumulate in the low lands, where there is moisture; and on the contrary, where there is sand and no moisture, the sterility must be augmented, which will have the effect of rendering the poor lands, that are dry, less productive, and the low lands that have moisture, more rich and fertile; producing a much greater contrast between the rich and the poor soils, than takes place in the northern latitudes.

Internal navigation is good, and all kinds of manures and bulky articles can circulate through the creeks and rivers at small expense; but the communication with the sea is obstructed by sand banks and bars, which makes the export of their surplus to foreign countries, difficult and expensive.

From the limits of the alluvial to within ten miles of the frontiers of the Tennessee, all is primitive. For some distance westward, it is rather level, and covered with a coat of alluvial, which in some places forms a tolerable soil; the country afterwards becomes broken, with much granite and gneiss, forming a thin soil to the foot of the mountains, where the gravel ridges begin; being steril and unproductive. The mountains are high and rugged, rather bare of soil; the vallies, as in all primitive, narrow, but fertile. It is in this state, that the whole mass of mountains begins to be primitive, as in New England; they are therefore more steep and rocky, and the vallies fewer and narrower; they constitute the dividing ridge, and the rivers which run to the westward pass through a considerable extent of primitive country, as well as those which drain the water off to the eastward.

Navigation, both internal and external, is bad; the rivers are incumbered with falls and rapids. The strip of transition of about ten miles broad, which touches the frontiers of Tennessee, is a rough, mountainous country, consisting of the quartzy aggregates in the high lands, and of course their soils; but the vallies, though confined and narrow, are fertile and productive.

South Carolina is entirely formed of alluvial and primitive, divided by a line, running by Columbia to Savannah; the alluvial extending east from that line to the sea. This alluvial is formed by the washing of the sea and by the sediment of rivers, which have their sources and run the greatest part of their course through primitive; it is therefore probable, that the dry part of the alluvial will incline to be sandy and light soil. The river bottoms and low situations, where there is water, will be rich and fertile, from the heat and moisture accumulating so rapidly the vegetable matter. It is likewise probable, that the remains of the madrepore rocks, which are equal to powdered limestone, may be brought by the currents from the south, and mixed with the sand on the sea islands, by which the nature of the soil would be materially changed for the better. The quantity of coral and madrepore rocks, that are forming on both sides of the gulf stream, where it passes the coast of Florida, gives probability to this conjecture.

The bed of blue marl, with shells, which crosses this state and Georgia, and extends even through the Floridas, will be likely to form a soil equal to limestone land; it is deposited by the sea, most probably in places protected by sand banks from the washing of the waves, and approaching to the alluvial made by the rivers.

Though the tide of the rivers ceases to flow twenty or thirty miles below the primitive, yet the navigation for craft is good to the edge of the primitive rocks, and the communication with the sea is tolerable by the means of bar harbours.

The primitive in this state, as North Carolina, is flat for some distance from the edge of the alluvial, and covered with a coat of earth, apparently the decomposition of hornblende and slate rocks, which makes a good soil, and becomes more rugged and broken as you proceed towards the mountains, which are high and steep, composed principally of gneiss and granite, and forming a thin soil, disposed to be gravelly; but the vallies or river bottoms, though narrow, are rich and fertile, diminishing in extent and number, as you proceed higher up the mountains, where the rapidity of the rivers gives little lime or still water to form the deposition of any other but heavy substances, such as rolled rocks or gravel.

The navigation in this, like the other primitive countries, is bad; the rivers, obstructed with falls and shoals, are too rapid and uncertain.

That part of the primitive which touches the alluvial, or the eastern and lowest edge, becomes flatter and more inclined to decomposition, as you proceed south on this and the two bordering states, at the junction of the primitive and alluvial; the former is decomposed to a considerable thickness below the surface, though covered with a considerable depth of alluvial; and above the junction where the primitive rocks appear in all the rivers and water courses, the surface is flat, and overlaid by a considerable mass of earth, for many miles to the westward. It is therefore probable, that heat facilitates the decomposition of primitive rocks more than water, and that the result of the decomposition, that is, the soil it makes, is more favourable to the production of vegetable matter, inasmuch as it decomposes more rapidly, and is not so liable to be washed during the operation.

Georgia, like South Carolina, consists almost entirely of alluvial and primitive; divided by a line running from Augusta by Milledgeville, Fort Hawkins, and the agency on Flint river, to the south. East of that line, to the sea and frontiers of Florida, the soil is alluvial, formed by the rivers and the sea. Some of the rivers, such as the Savannah, run through primitive country, and form sandy, light soil. The Altamaha holds the greatest part of its course through alluvial country, and will most probably form richer and more productive depositions.

The sea may form alluvial of a superior quality, by being mixed with the broken remains of the madrepore rocks in the vicinity; it is even probable, that the islands on the coast may have madrepore and coral rocks for their foundation, which in warm climates decomposes rapidly into very good soil.

Wherever there is the command of water in this climate, vegetable matter will accumulate, which makes all the low lands on the rivers rich and fertile, though the dry land may be poor and sandy. It is however probable, that the alluvial above tide water, being level and not much washed, may be tolerable good soil. River navigation is good, and boats run up to the edge of the primitive, and coasters to the head of tide water, which is, in some of the rivers, nearly fifty miles below the primitive ridge; the communication with the sea by bar harbours is not difficult.

To the north, a little westerly of the limits of the alluvial, is the primitive formation, level, and covered with earth of tolerable quality; for some distance towards the mountains, this plateau of level country, decreases in width the further you go west, finishing in a rough, broken country. To the north it consists principally of gneiss and granite; as you approach the mountains, which are high, the soil is rather thin and poor, but the vallies between them are rich and fertile, though narrow.

A small angle of this state crosses the mountains, and touches at a point the river Tennessee; this is in part transition, and the rest secondary, which corresponds in quality with the same classes of rocks in North Carolina, and the state of Tennessee.

The part of this state, which lays upon the declivity of the Alleghany mountains, sheltered to the south from the northerly winds, and open to the mild temperature of the south and southwest breezes, ought to be, and indeed is, one of the most moderate climates of the United States; in a great measure free from the sudden and violent changes of heat and cold, produced by the free circulation of those two opposite currents of air from the north and south, bringing along with them the temperature of the opposite climates, from whence they come. It may likewise be considered as a climate more congenial to the growth of plants from the south of Europe, such as the vine and the olive, than any situation north of it in the United States.

From the circumstance of the range of mountains approaching nearer and parallel to the sea, the rivers are shorter, and run their whole course in nearly the same latitude, which renders the floods less dangerous and more under the command of dykes and barriers, than they are in the western country, where the whole basin of the Mississippi is drained by one river, and the melting of the snows in the north inundates and ravages the plains in the south, with a force and weight of water, difficult to be controlled by the limited exertions of man, and perhaps not to be accomplished by a thin and scattered population.

The foregoing short description includes the whole Atlantic states; that is, all the states which consist of a variety of all the different classes of rocks in a geological point of view; the application of the properties whereof to agriculture, in modifying the nature and fertility of soils, is rather mixed and complicated. The rest of the United States, round by the lakes, and we have reason to believe, even as far west as the foot of the Stony mountains, consist of two classes of rocks, the secondary, and the alluvial made up of the washings of the secondary; these two classes possess properties the most favourable to the production of vegetables, first, in situation; tending always towards the level and even surface, and secondly, in component parts; being made up of particles ground and worn by repeated friction into minute powder, mixed and triturated so as to produce earths and soils best calculated for the growth of plants.

In this vast extent of country therefore, the different nature and fertility of soils does not depend as much on any difference in the quality of the rocks whereof the soils are formed in a geological point of view, for they are nearly the same, but chiefly on the difference of climate, and relative situations as to height, the regular or irregular supply of heat and moisture depending on the constancy or uncertainty of the agents that furnish them, including the various effects produced by the freshets and inundations of the rivers, with the nature of the rocks at their sources, and through which they may have run for some distance.

The division, called the Mississippi territory, extends from the confines of Georgia to the limits of Louisiana and the river Mississippi; and from north to south from the frontiers of Tennessee to Florida, and the gulf of Mexico. This division is composed of secondary, and the alluvial made up of the decomposition of secondary rocks; both classes of rocks contain the materials necessary to the formation of good loam, and will most probably make good soils.

That part of this district, which lays on the declivity of the hills towards the south, protected from the north wind and open to the south, will most probably enjoy an equal and moderate climate; and like the part of Georgia in a similar situation, it will be favourable to the production of the vine and the olive. Where it touches the river Mississippi, it will partake of the river alluvial, and the inconveniences of its floods and marshes; and that part bordering on Tennessee, will most probably be similar in soil, produce and climate, to the coast of the great basin which it joins.

Bounded on the west, north, and east side by navigable rivers, and drained by three other rivers that communicate immediately with the gulf of Mexico, this district ought to enjoy a good navigation, both internal and external, while it is in some measure free from the inundations and uncertainty of the rivers of long course; those rivers which have run through it, are of a size capable of being controlled by the industry of man, and at no season subject to the inconvenience of great periodical floods, or the obstruction of ice towards their sources, which is more or less the case with those rivers that rise in northern latitudes.

From the gradual declivity of the ground, and from the rivers which run through the country, rising in a rather elevated situation at no great distance, the springs of water will most probably be abundant, and the water tolerable; the east part of the territory, with the western part of the state of Georgia, are the only body of lands in the United States, which lays on a southern coast, open to the influence of the southern breezes, and sheltered from the sudden changes which accompany the northerly winds on this continent. It may therefore be reasonably inferred, that the climate is one of the most moderate in the United States, or at least that part which has been as yet settled; and that the range of the thermometer is not so extensive, nor the extremes of heat and cold so great as in those places exposed to the influence of the northerly winds. It is equally probable, that the portion immediately south of the highest part of the termination of the Alleghany mountains will be the best protected from the influence of the north wind, and of course the most temperate climate, though the soil may be less productive from its proximity to the primitive.

The head waters of the Tennessee river, rising in a mountainous country, consisting of primitive and transition rocks, and running a considerable distance through them, will be apt to bring down considerable quantities of sand and gravel, composed of quartz, and sandstone of transition pebbles; of course, the state of Tennessee may contain a greater quantity of gravel ridges or sand beds, than the other states in this great basin; but the state of Kentucky, made up of the alluvial that descends the Ohio, collected from a coal, grey wacke, and limestone country, will most probably be rich and fertile; the same causes will produce the same effects, with a little allowance for difference of climate, in the states of Ohio, Indiana, and Illinois. The Michigan and North Western territory, being still further north, and having more of their alluvial originating from the washing of the lakes, will require still a greater deduction from their fertility and productiveness. The whole basin consists of secondary, or alluvial resulting from secondary decompositions; and therefore has the best chance of a good natural soil, while its level situation, not liable to be washed, insures it all the benefits of an accumulation of vegetable mould, from the fall of the leaves, decayed grass, and other vegetable decompositions.

There are a great many detached masses of granite and sienite, scattered over the surface of that part of the basin, which lays to the north of the Ohio river, but runs to the south; from which it is probable, that they have come from the north, perhaps from the primitive mountains, north of the great lakes; if so, the movement of waters must have been at some former periods different from what they are now; and those waters (in place of depositing the decomposition of secondary, as all the rivers rising near the lakes do now) most probably brought with them, along with those masses of primitive rocks, the remains of primitive mountains, and may have left more sand and gravel on the northern parts than is to be found in the south.

West of the Mississippi, the whole passes under the name of the Missouri territory, and near the sea it is called Louisiana. The whole of this territory, to near the foot of the Stony mountains, appears to be secondary; but what is the nature of the Stony mountains, or how much of the alluvial brought down from them by the large rivers (which have been the principal agents in filling up the west side of the basin) may be the washings of primitive mountains, is uncertain. The tops of the Stony mountains are covered to a considerable extent with perpetual snows and pendent glaciers; a proof that they are vastly higher than the Alleghany mountains; of course, the numberless streams and torrents, which descend their flanks, roll with much more violence and rapidity a far greater quantity of water from the melting of the snows, than can be expected to descend from mountains of the height of the Alleghany. It is therefore reasonable to suppose, that they will deposit at the foot of the Stony mountains, and for some considerable distance, a much greater quantity of sand and gravel than the streams from the west side of the Alleghany.

This sand and gravel, when dried up by a southern sun, may form extensive basins, deprived of water; they will become deserts, while the banks of rivers or moist places may make tolerable soil. These causes may render the soil of the western part of this extensive basin unequal, and vibrating between very poor and tolerably rich.

Rivers, which rise on the mountains and run over such a vast extent of country, carrying all their waters and deposits towards one common centre, and all joining the sea by one common outlet, are generally liable to periodical inundations, and bring down with them a great body of water accompanied with a great deal of sediment or alluvial. This alluvial is generally first deposited on the bed and banks of those rivers, raising them very much above the level of the surrounding country, and giving the rivers the appearance of running upon a ridge, which is the cause why the surrounding country is liable to be flooded to a great distance by the first inundation; the draining of which, after the rivers subside, is very much impeded by the circumstance of the bed and banks of the rivers being on a higher level, and preventing the water from running off, forming large lakes and marshes, until the heat dries them up, to experience again the same drowning as at the first periodical inundation. When the weight of waters that roll down in such rivers is so great as to be out of the controul of the labour of man, it is attended with great inconvenience and uncertainty to the farmer, and by rendering property precarious, becomes one of the greatest hindrances that can be put in the way of improvement; but this is fortunately limited in the basin of the Mississippi, to the lower part of the largest rivers, and even they, like the Nile, may perhaps be brought hereafter under the controul of persevering industry.

Though this basin is highest on the west, north, and east side, and declines gradually to the south side of the great northern lakes, there is no range of mountains or any basin sufficiently elevated to protect it against the northerly winds, which range through the whole without obstruction, and carry with them the sudden changes of temperature, common to the north winds on this continent. It is not improbable, that the frequency of those north winds may be limited by the south wind being forced up the basin by the constant effects of the trade wind, filling the bay of Mexico, and the range of mountains at the bottom of the bay turning the current to the north; still, there is a change of the opposite winds, and a sudden transition from cold to heat.

This transition of temperature may certainly become every day less injurious, both to men and vegetables, in proportion as they become habituated to the climate, and acquire new habits better fitted for their situation; for it is probable, that we have not been struggling long enough with the inequalities of the climate, to have lost our European habits; which being forced on us by an order of things quite different, does not suit this country. Most of the vegetables, fruit, &c. which we cultivate, have likewise their European habits, which they have not yet had time enough to change.

On examining both the geographical and geological maps of the United States, it will appear, that they are divided into two distinct and separate parts, differing materially from each other in their relative situation and means of communication with the rest of the globe, as well as in their interior circulation and communication within their own territory. The national line of separation between those two great territories, is that range of mountains, called the Alleghany; which from the poorness of the soil, and the difficulty of getting to market, will most probably be the last part of the continent thickly inhabited.

On the west side of this ridge is the vast basin of the Mississippi; geologically composed of similar substances, enjoying the advantage of all climates from the 29th to the 45th degree of latitude, having the command of the tropical productions as well as those of the north, circulated through its most distant extremities by the immense ramifications of one great navigable river, communicating with the ocean only at one point; navigable with some danger and difficulty by merchant ships, but inaccessible to large ships of war.

On the Atlantic side of the ridge, they enjoy nearly the same variety of climate and production; but for the medium of communication, from north to south, they depend on the sea, which is accessible at all points, both to merchant ships and ships of war.

The inhabitant west of the mountains is forced by situation to consider the internal navigation as the cause of his riches, independence and happiness; but having only one leading sea port, the foreign commerce will most propably be considered of secondary moment, and be given up to those who can do it cheapest. At the same time, confident of his strength, and having only one point to defend, it is difficult for his rulers to persuade him of the necessity either for a fleet or an army; so that both his situation and interest force him to be at peace with all the world.

It is not the same with the inhabitant on the shore of the Atlantic. Placed on an extensive coast, accessible at all points to the depredations of a superior fleet, he is easily persuaded by his rulers to keep up a fleet and an army to protect commerce, *&c.* tending doubtless to involve us in all the wars of Europe, at the enormous expense it must always cost a government such as this. Taxes follow in proportion. The inhabitants of the west pay their proportion of these taxes without the same feeling or interest. The breach widens by the natural gravitation of interest arising out of situation; and nothing can long keep them together but the utmost prudence and economy in the federal rulers, by avoiding war and every cause of expense.

On this earth, or in the page of history, it is probable no place can be found of the same extent, so well calculated to perpetuate a free and equal representative government, as the basin of the Mississippi, both from its physical advantages and the political constitutions on which the state of society is bottomed.

By enjoying the different productions of a variety of climates through a rapid and easy circulation to the extremities of the country, by means of rivers, secured against the depredations of any foreign enemy, they set out with advantages, which thousands of years of labour have not been able to obtain for other nations.

That territory, being inclosed within a chain of mountains, or lakes, together with the comparative weakness of their neighbours, guarantees the inhabitants against the least apprehension of invasion, while their having only one bad harbour, unfit for ships of war, takes away the ability of invading by sea the property of others—removes in a great measure the temptation of war—and deprives the rulers even of an excuse of keeping either a fleet or army establishment, which hitherto have always produced the ruin of free and equal representative governments.

Bottomed on a free and equal representation of men, they will most probably be governed by the majority; not like the greatest part of the Atlantic states, which are founded on a representation of property, and liable to be governed by the few or the minority. Monopoly of property ensures monopoly of power, and the means of perpetuating it, as is proven by the experience of all other nations. They will most probably be divided into twenty or thirty free and independent representative governments, which will guarantee them against any sudden usurpation. But as all the nations in the old world who possessed any share of equal representation, have been deprived of it by the intrigues of their rulers, experience forbids the placing great confidence in the continuance of equal representation, even on this favourite spot, though we may be allowed to indulge in the hope, that it will long be governed by the positive majority, and remain a place of refuge to oppressed humanity.

EXPLANATION OF PLATE II.

THIS Plate contains five sections of the United States, from the sea shore to the great secondary basin of the Mississippi, with the comparative elevation of the range of mountains called in general the Alleghany. The scale of height on the margin is divided into ten parts; the first five is two hundred feet each, to give some apparent height to the small hills and low country; the upper half of the scale is equally divided into five, and is one thousand feet, each division; making the whole scale six thousand feet. It is not meant that the highest part of the ridge shall be found exactly where the line passes, but that the highest part of the ridge in the vicinity of that line, shall most probably be found of the height marked by the scale in the section.

The colours correspond with those on the map; that is, the Siena for the rock, red for the transition, the blue for the secondary, and the yellow for the alluvial, &c.

The Catskill mountains are here represented as transition, tnough in many places west of the Hudson the transition is found only on the lower ground, as the foundation; though the tops of the hills are frequently crossed with secondary.

Fig. I. No. 1. Camden in Penobscot bay, district of Maine.
2. Kennebeck river, district of Maine.
3. White Hills, New Hampshire.
4. Lake Champlain.
5. Wellsboro' on Lake Champlain.
6. Oxboro, fifty miles east of Kingston on Lake Ontario.

Fig. II. No. 1. Plymouth in Boston bay, Massachusetts.
2. Springfield on Connecticut river.
3. Green mountains.
4. Hudson river in the state of New York.
5. Catskill mountains are here represented as transition, though in many places west of the Hudson the transition is found only in

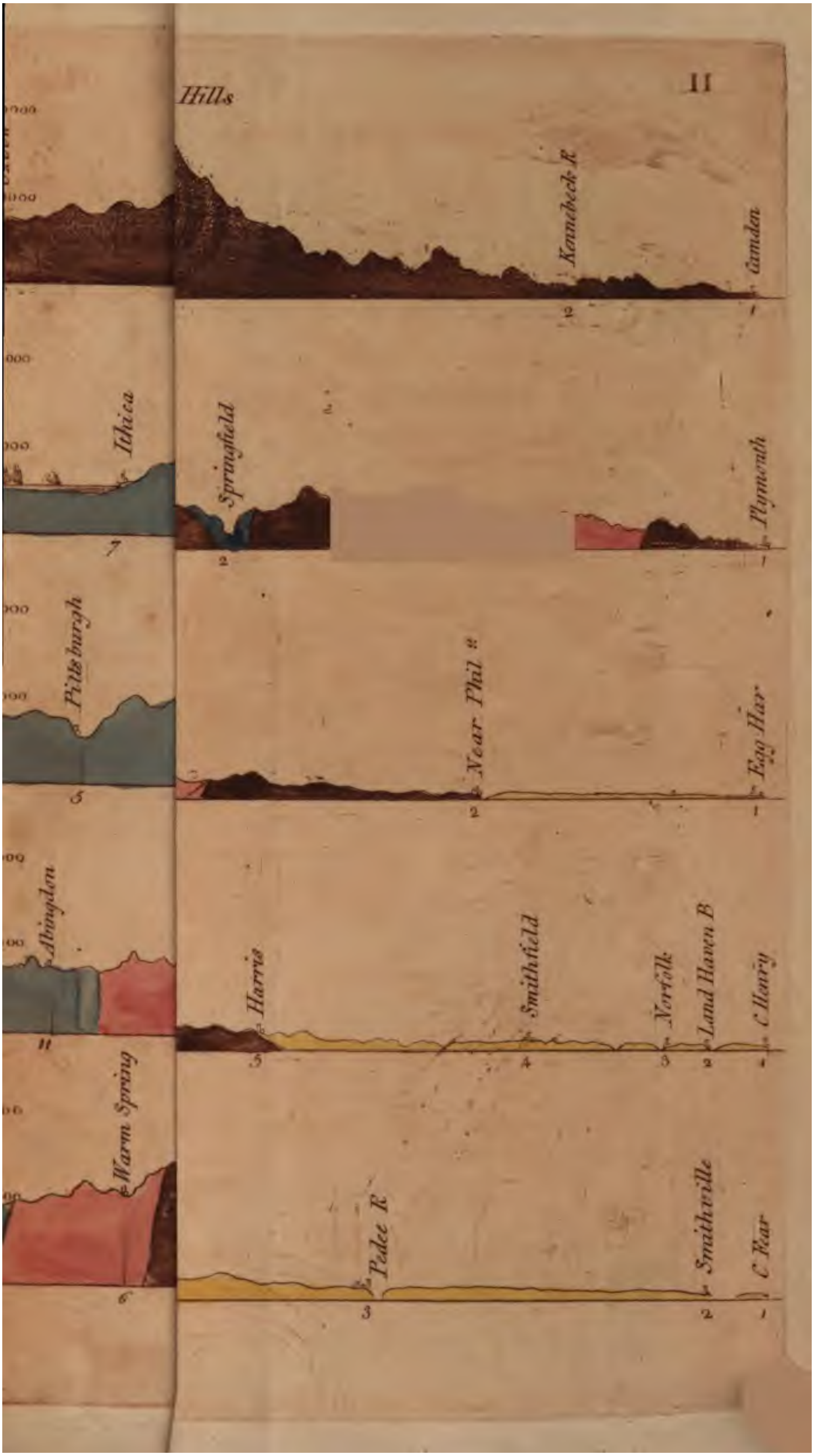
the low country, as the foundation, while the tops of the hills are frequently crossed with secondary.

6. Delhi.
7. Cayuga lake at Ithica.

Fig. III. No. 1. Egg Harbour in New Jersey.
2. A little to the S. W. of Philadelphia.
3. York in the state of Pennsylvania.
4. Summit of the Alleghany mountains.
5. Pittsburg in Pennsylvania.

Fig. IV. No. 1. Cape Henry, Chesapeak bay, Virginia.
2. Linnhaven bay do.
3. Norfolk do.
4. Smithfield do.
5. Harris do.
6. Lunebourgh do.
7. Roanoke river do.
8. Williamsville do.
9. Martinsville do.
10. Greenville do.
11. Abingdon do.

Fig. V. No. 1. Cape Fear in North Carolina.
2. Smithville do.
3. Pedee river do.
4. Catawba river do.
5. Union do.
6. Warm Springs, near the frontiers of Tennessee.


II
Hills
Kennebeck R
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2
1
Ithica
7
Springfield
Plymouth
2
1
Pittsburgh
5
Near Phil a
Egg Har
2
1
Abingdon
Harris
Smithfield
Norfolk
Land Haven B
C Henry
5
4
3
2
1
Warm Spring
6
Pedee R
Smithville
C Fear
3
2
1